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# An illustrative guide to the fixed orthodontic appliance for the General Dental Practitioner – inner content

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Salahuddin M Dawjee

University of Pretoria

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## **Dedication**

When the body is deformed it affects the disposition of the soul. Orthodontics is that discipline of dentistry that deals with the planned movement of teeth to enhance beauty and function. It uplifts the psyche and nurtures optimism.

This book is dedicated to those deprived of the opportunities that beauty procures because of an inability to afford an attractive smile.

And

To the Dental Professionals in service of humankind - those who place the needs of others above their own.

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## Foreword

It is a humble honour and pleasure for me, to be invited by Professor S.M. Dawjee, to write the foreword for his textbook "An illustrative guide to the fixed orthodontic appliance for the general dental practitioner".

In fairness and equity to our fellow humans, we as orthodontic specialists and general dentists, as "Health Care Workers", share a burden to provide our patients with a functional occlusion and pleasing smile, enabling a confident, healthy and happy person to fulfill life's journey. In an ideal world, there will always be access to health care, including the benefits and access to all branches of dentistry.

Since we are living in a time approaching the year 2020, when beauty and aesthetics are considered paramount to being successful in life's many endeavors (friendship, acceptance, love, employment, enjoyment), the importance of having a great looking smile, is becoming ever more desirable and important for people across the world, of all ages. Today, patients from pre-teens to octa and nona-generians and even beyond are wanting to look good!

Certified, registered specialist orthodontists are not always available, nor accessible to all orthodontic patients who need, want or may ultimately benefit from trained specialist orthodontists and thus regularly rely on the general / family dentist to diagnose malocclusion and either provide treatment, or refer them for specialist treatment by an orthodontist.

General dentists in dental school, receive training to diagnose malocclusion and are then expected and required to make the following decisions and judgement calls:

1. Does the malocclusion need to be treated?
2. Does it need to be treated now (for example an anterior crossbite with a functional shift in an 8 or 9 year old patient), or is it better to delay definitive treatment until all the permanent teeth have erupted (for example a 14 year old patient with minor upper crowding and malalignment)
3. Can the patient be treated by the general/family dentist, with the expectation of predictable orthodontic outcomes?
4. If the patient is unwilling or unable to access specialist orthodontic services, is the general/family dentist able to provide orthodontic services, which will improve the malocclusion, albeit with a potentially compromised result?

Whilst there is no doubt that when available, it is preferable to have specialist treatment undertaken, the family dentist still has an important role to play, being the first observation point of diagnosis of an existing or developing malocclusion. Interceptive orthodontic treatment is often successfully accomplished in the hands of the family dentist (for example habit control, space maintenance and single tooth crossbites, *inter alia*).

Professor Dawjee's textbook will be a helpful resource for the family dentist, to provide help and guidance, in those instances where the family dentist is required to provide non-specialist orthodontic services to patients. In this way, access to services will be improved and the patients will benefit from more predictable orthodontic outcomes. That said, there are those difficult to treat malocclusions, where it is sometimes better to not treat, than to attempt to treat!

This textbook is written in an easy to read fashion and provides many illustrations and "pearls" for the general dentist embarking on the exciting path of improving patients' lives with orthodontic treatment.

**William A Wiltshire,**

*BChD(HONS), MDent, MChD(Orth), DSc(Pret), FACD, FPFA,  
FRCD(Orth)(Canada)*

**Professor and Head of Orthodontics**

**Dr Gerald Niznick**

**College of Dentistry**

**Rady Faculty of Health Sciences**

**University of Manitoba**

**Canada**

**4<sup>th</sup> January 2020**

## **Acknowledgement**

In the African culture, 'a person is only a person because of others' and it would be unmindful not to thank the kind souls who assisted me directly and indirectly in the production of this book.

My parents and grandparents. While you are no longer with us, the memory of your struggle to give those who came after you a brighter future, will always live on.

My wife Ghyroonisha for your relentless patience and support.

My children Haajierah, Maryam and Muhammad. I am inspired by your achievements and I thank you for your love and respect.

My teachers and mentors, who provoked me academically to extract the best in me.

My friends, colleagues and students who challenged me with their interrogations. I hope you will find some answers in this book.

Lastly, I am blessed to have grown up in a poor and opportunity stifled location during the apartheid era in South Africa and treasure the social support and emotional comfort that a society in poverty and adversity unselfishly offers. I draw strength from the community I was born to and will always be indebted to all my guardians at that time. Each one of you nurtured me in a special way.

## Preface

According to Sufi tradition, true mentors are as transparent as glass. They let the light of God pass through them. That which is unknown is with God and that which we know is for the benefit of humanity. Eastern custom counsels that knowledge is like brackish water at the bottom of an old vase unless it flows. We should therefore not be custodial of our talent.

This book attempts to describe the fundamentals of the fixed orthodontic appliance and its use in limited clinical situations. It is not complete in any measure or the final word. Biological aspects of tooth movement, the aetiology, diagnosis and treatment planning of malocclusion does not fall within the ambit of this production and can be sourced from reliable texts of authors who are experts in the field. Readers are advised to reference these.

Most of what is contained in this book is the culmination of the author's own clinical experience and born from a perception that a simple, concise and relevant description and explanation of the fixed orthodontic appliance is lacking and needed. It is the author's hope that this book will ease this deficit and rescind the author's challenge to his students that 'you won't find this in a textbook'.

While a basic design and application of the fixed orthodontic appliance is presented, there exist many opportunities for modification and improvisation of the appliance and its accessories - aspects that should not be dismissed, - but investigated and adopted for the benefit of better patient care. All mechanical and procedural activities related to the fixed appliance explained in this text are designed for right handed operators and the author sincerely apologises for not rendering explanations for left handed professionals.

Much of the discussion contained in this book deals with the application of the fixed appliance in Class I situations and little reference is afforded to the use of the fixed appliance in Class II and III malocclusions. The latter is within the ambit of specialized Orthodontic professionals.

As a novice to the art of compiling a book the author attempted to include an index but abandoned the exercise as it bordered on a near duplication of the actual text and the table of contents does suffice as a directive to any topic.

Within the text, readers will encounter matters of importance and interesting aspects that have been highlighted and intended to infer the following:

**Clinical tip: Green**

Cautious tip: Red

Cost saving/Management tip: Blue

The author trusts that any saving in treatment cost derived from this presentation will be for the patients' benefit and welfare.

As this is the first, and hopefully not the last attempt at a work of this nature, the author is open to any comments, criticism or advice and may be contacted at:

[sdawjee@yahoo.com](mailto:sdawjee@yahoo.com) or [dr.smdawjee@gmail.com](mailto:dr.smdawjee@gmail.com)

## List of abbreviations

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AOB – Anterior open bite  
AMO – Alveolar moulding obturator  
AW – Archwire  
COR – Centre of resistance  
EL – Elastic ligature  
FOA – Fixed Orthodontic Appliance  
GDP – General Dental Practitioner  
IPR – Interproximal Reduction  
LA – Lingual Arch  
NiTi – Nickel Titanium  
OB – Open Bite  
PC – Power chain  
SL – Steel ligature  
SS – Stainless Steel  
TAD – Temporary anchorage device  
TPA – Trans-palatal arch

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## **Chapter 1**

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### **Introduction**

#### **The fixed orthodontic appliance (FOA)**

The FOA consists of brackets and other attachments that are fixed to the teeth in order to move them into defined positions until such time that the dentition fulfils the intended requirements of aesthetic harmony, functional efficiency and structural balance.

#### **Appointment sequence**

Orthodontic treatment is a lengthy exercise and consist of multiple appointments. Depending on the complexity of the problem, treatment can extend over a six to 24 month period. Generally the sequence of appointments is as follows:

1. Consultation and preliminary diagnosis, and an estimation of treatment cost and time.
2. Taking of pre-treatment records - photographs, radiographs and impressions for study casts, and other necessary diagnostic aids.
3. Confirmation of treatment plan, informed consent (both clinical and financial), and the placement of separating elastics or bonding of buccal tubes on the molars. Referral for other dental treatment such as a scaling and polish, extractions, restorations etc.
4. Banding and bonding.
5. Recall and follow up visits, every six to eight weeks.
6. Deband upon completion of treatment, removal of bond residue, impressions for retainers and referral for scaling and polish.
7. Taking of post treatment records - photographs and impressions for study casts, and the delivery of retainers.

8. Two quarterly recall visits followed by biannual visits.

## Chapter 2

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### Instrumentation

#### Instruments

Orthodontic procedures demand the use of many specialised tools and instruments, along with several other appliances used in general dentistry. The most commonly used orthodontic instruments are:

#### Adams pliers

Used for bending heavy-gauge wires and adjusting removable appliances.



*Figure 1: Adams plier*

#### Arch-forming pliers

Used to form and contour archwires (AWs), either round or rectangular, as well as to incorporate a curve of Spee into an AW.



*Figure 2: Arch forming plier*

### **Band pusher**

Used for positioning and seating the band, as well as for burnishing or adapting the edges of the band around the tooth.



*Figure 3: Band pusher*

### **Band seater (Band biter)**

A plastic or metal instrument consisting of a handle and a bite stick that makes use of the patients' biting force to aid with the seating of a band.



*Figure 4: Band seater*

### **Bird-beak pliers**

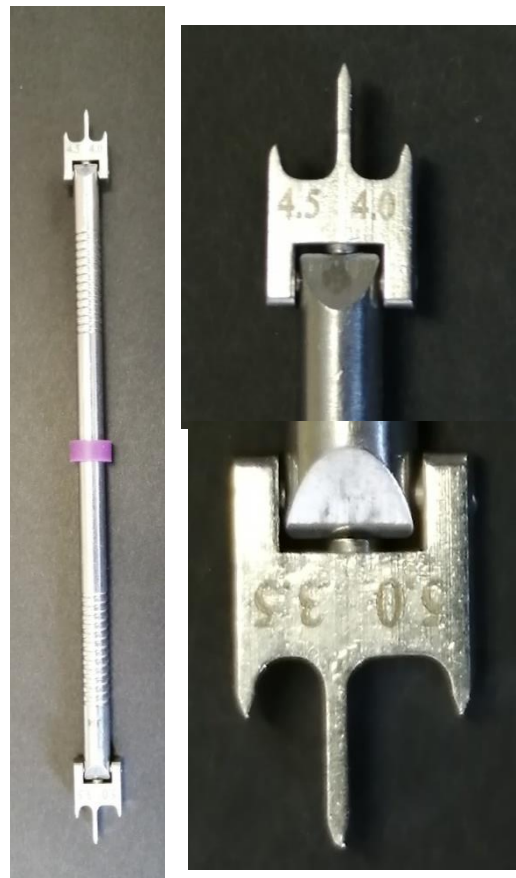
Used for the routine bending of AWs.



*Figure 5: Bird beak plier*

### **Bracket height gauge**

Used to facilitate the placement of brackets at standard and predetermined distances from the incisal edges or occlusal surfaces of specific teeth.



*Figure 6: Bracket height gauge*

### **Bracket tweezer**

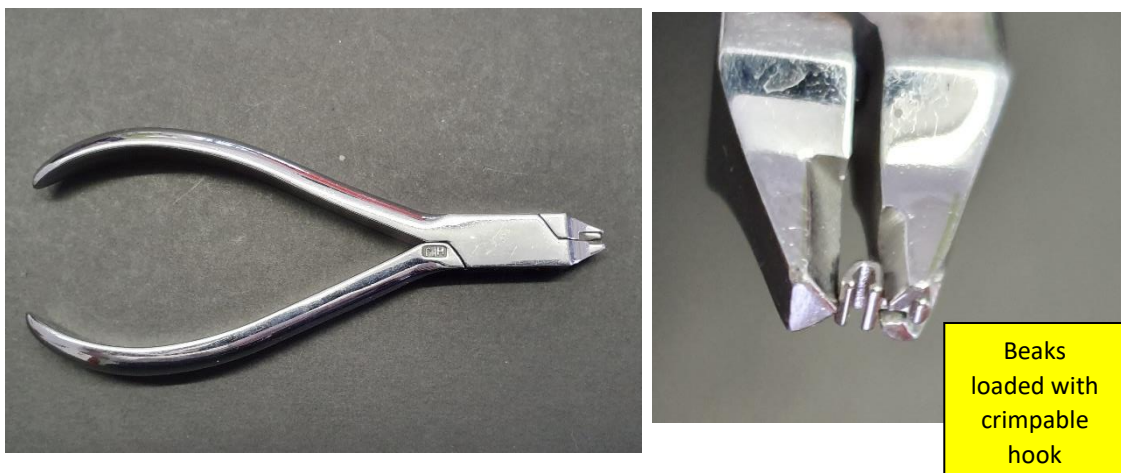
For the delivery and placement of brackets and other orthodontic attachments on teeth.



*Figure 7: Bracket Tweezer*

### **Crimpable hook plier**

Used to add and fix a crimpable hook to an AW



*Figure 8: A crimpable hook plier*

### **Debanding plier**

Used for removing bands from teeth.



*Figure 9: Debanding plier*

### **Debonding pliers**

A plier with two mirror-image jaws with sharp cutting tips formed around a cylindrical opening. The cutting tips generally do not make contact when closed fully. The bracket is removed by peel and shear forces by placing the cutting tips at the bracket-adhesive interphase and squeezing.



*Figure 10: Debonding plier*

## Dental Instruments

A basic set of instruments in common use by a general dental practitioner (GDP)



*Figure 11: General dental instruments*

## Distal-end cutter

A special wire cutter with the juxtaposed cutting edges set at right angles to the long axis of the instrument to facilitate cutting of the distal end of the AW, intraorally.



*Figure 12: Distal end wire cutter*

### **Elastic separating pliers**

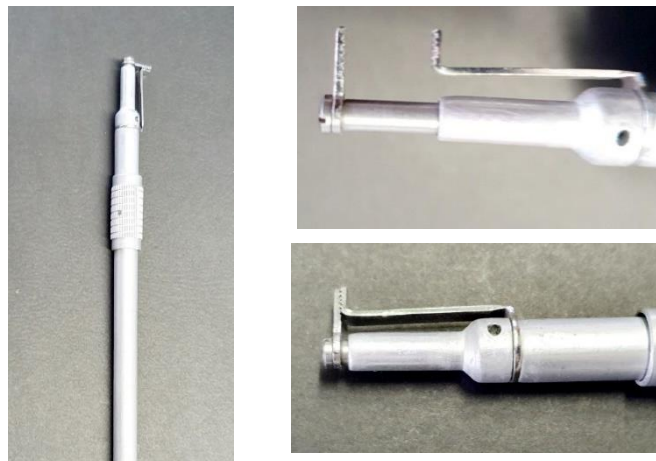
Reverse-action pliers with two long beaks that are angled for better access. They are used to stretch, hold and place elastic separators between adjacent teeth.



*Figure 13: Elastic separating plier*

### **Orthodontic force gauge**

To determine the force value on the active components of the fixed orthodontic appliance.



*Figure 14: Orthodontic force gauge*

### **Hard wire cutter**

A cutter designed similar to a pin and ligature wire cutter, only more robust and larger, and used for the cutting full-dimension AWs.



*Figure 15: Hard wire cutter*

### **Ligature director (Pitchfork instrument)**

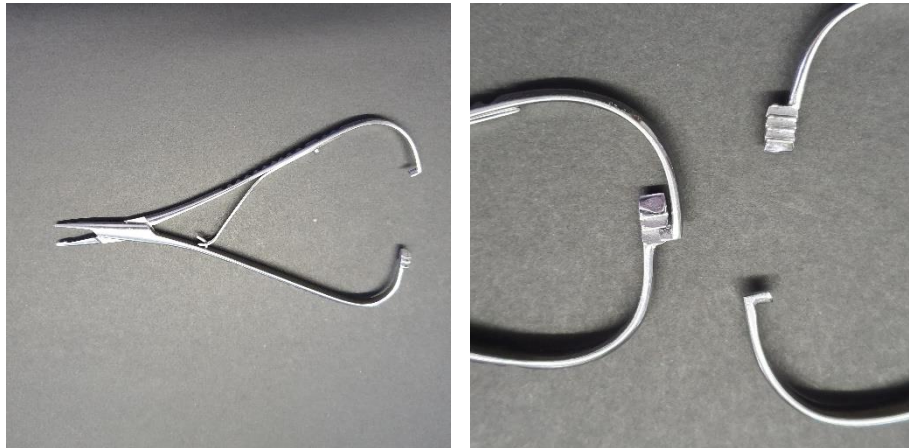
A stainless steel instrument carrying a straight or angled tip with a notched tip capable of engaging wires. Available in double-ended versions.



*Figure 16: Ligature director or tucker*

### **Mathieu needle holder**

Pliers with long, thin handles equipped with a positive-locking ratchet and spring for instant opening and closing. The opposing tips are serrated and may have tungsten carbide inserts for extended instrument life. Used mainly for tying stainless steel ligatures (SLs) as well as for placing elastic ligatures (ELs).



*Figure 17: Mathieu needle holder (self-releasing)*

### **Pin and ligature wire cutter (Light wire cutter)**

Cutter with two tapered and pointed opposing beaks, terminating in delicate and sharp cutting edges. Used for cutting steel ligatures and elastomeric chain.



*Figure 18: Pin and ligature cutter*

### **Retractors**

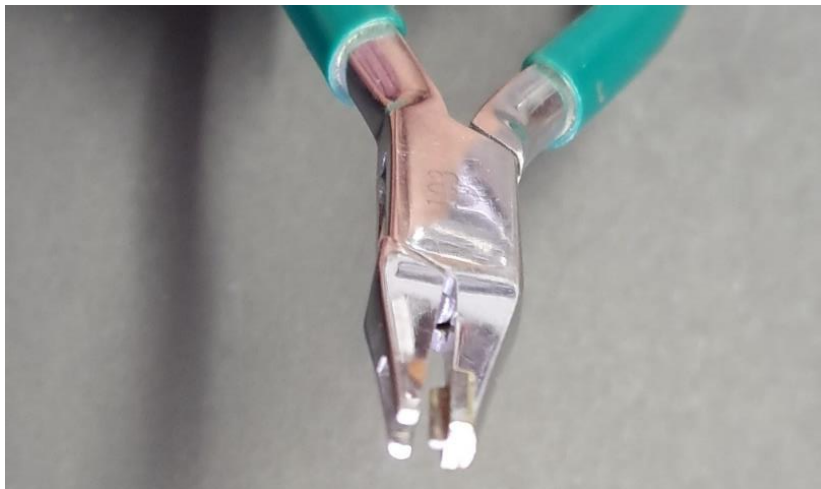
Used to keep the lips and cheeks away from the field of operation.



*Figure 19: Lip and cheek retractors*

### **Stop forming plier**

Used to crimp a stop in the AW



*Figure 20: Stop forming plier*

### **Three pronged plier**

Used for adding a gable bend in a wire.



*Figure 21: A three pronged plier*

### **Weingart utility pliers**

Used for holding or gripping the AW to place it and remove it from buccal tubes, or to make adjustment bends (e.g. cinching).



*Figure 22: Weingart plier*

## **Chapter 3**

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### **Bands and Tubes**

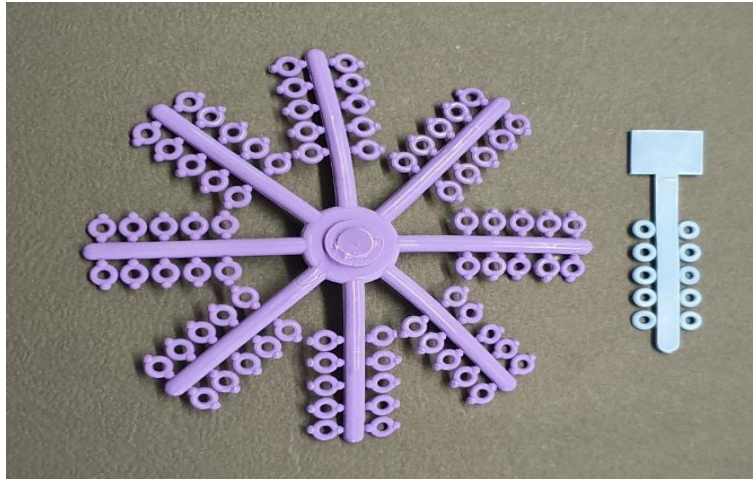
## **Molar Bands**

Unlike incisors and premolars, molars are large multi-rooted teeth that have a high bone surface to root ratio, and therefore offer a greater resistance to orthodontic force. This root-bone relationship of molars is advantageous in that it can serve as an anchor to move incisors and premolars. To harness this function, the orthodontic attachments that are placed on molars should be firmly cemented and not loosen when large forces are applied to it. To this end, bands are cemented to the molars. These bands are made of SS and are available in a range of sizes. Bands may also have various attachments and modifications adapted to them.

## **Separating teeth**

Creating space for the placement of orthodontic bands is achieved with separating elastics. These elastics are positioned between teeth with a separating plier. The most commonly banded teeth are the upper and lower first and second molars. Separating elastics are placed in the mesial and distal interproximal areas of these teeth to create space for the placement of orthodontic bands around them. Separating elastics are usually left in position for one week but not more than two weeks. As the elastic contracts and reverts to its original size, the separating elastics pushes the adjacent teeth apart creating an interdental space around the tooth to enable the placement of orthodontic bands.

Separating elastics are also useful in any situation that requires teeth to be pushed apart, for example, when space needed for erupting first or second permanent molars that may be slightly impacted against its predecessor. A separating elastic that is placed between the fully erupted tooth and the partially unerupted tooth should provide sufficient force to displace the latter distally and allow a free path of eruption. Separating elastics can also help in the provision of minimal space (1mm) to align a tooth, for example, a slightly lingual or palatally displaced second permanent premolar. Use of separating elastics mesial and distal to this premolar followed by or in conjunction with a fixed appliance can assist in aligning the tooth.



*Figure 23: Separating elastics*

### **Separating procedure**

Collect/tug a separating elastic off the elastic holder with the closed beaks of a separating pliers. Compress the handles of the separating plier to stretch the separating elastic. Retract the patient's cheek with a mouth mirror and gently slide one side of the separating elastic ring from the occlusal aspect into the interdental embrasure of the two teeth to be separated. The action of engaging the separating elastic interdentally should be a bucco-lingual movement similar to the practice of interdental flossing. The separating elastic is in its correct position when half of the elastic ring lodges below the contact point and the other is visible occlusally above in the interdental embrasure.



*Figure 24: A separating plier loaded with a separating elastic*



*Figure 25: Tooth separation with separating elastic*

Excess force should not be applied during the placement of the elastic as this can lacerate and injure the gingiva or cause both limbs of the separating ring to slip below the contact point

Upon completion, be sure that the separating elastic encircles the embrasure area with some segment locked occlusally as the elastic can slip subgingivally and migrate down the periodontal ligament space over the period of wear.

The patient will usually experience some pain as the separating elastic contracts and a mild analgesic, such as paracetamol, may be prescribed. Diet and oral hygiene should continue as normal and patients are instructed not to remove the separating elastics. Patients should also be advised not to be concerned if the separating elastic extricates, as this is indicative that adequate space between the involved teeth have been created.

At a recall appointment, which should not be longer than two weeks after placement, the separating elastics are removed by tugging them occlusally with a dental probe. Bands can then be fitted around the molars if this was the intended purpose for tooth separation. Occasionally the interdental space opens rapidly and the separating elastics may dislodge and disengage prior to the one or two week recall appointment.

Ensure that all the separating elastics are removed before band placement, as any remaining separating elastics can unnoticeably dig into the underlying tissues with adverse complications to the periodontium and supporting bone.

In cases where bands are positioned and impressions of these are taken for the fabrication of supplementary fixed appliances such as a transpalatal arch (TPA) - or a lingual arch (LA) appliance, the spaces between the separated teeth must be maintained until the next visit when such auxiliary appliances have been

fabricated and are ready to be cemented. Thicker separating elastics can be used to preserve the space between teeth while the appliances are fabricated.

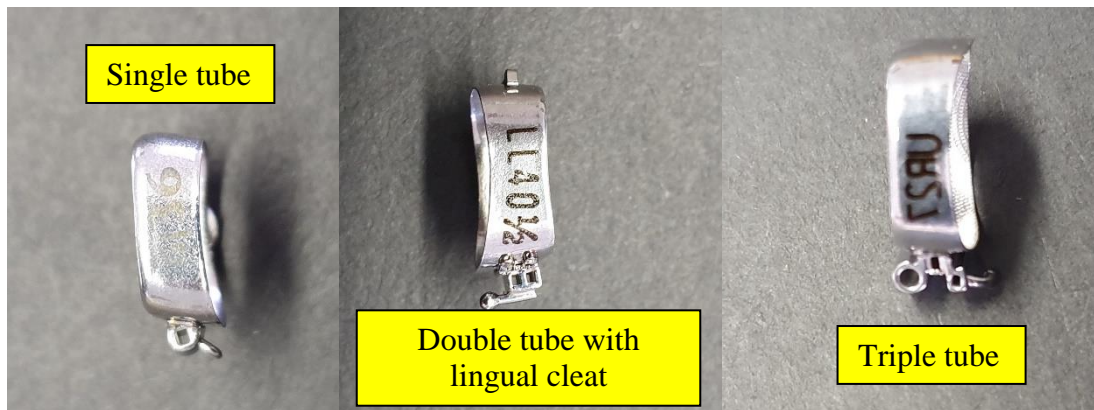
When the contact points between adjacent teeth are tight and impregnable and the separating elastic are unable to pass through the contact area, brass wire may be used to separate the teeth. These are soft malleable round wires that come in 1-1.5cm lengths. They are handled in a manner similar to a suture needle. Using a Mathieu needle holder, the one end of the brass wire is threaded from the buccal side below the contact point between the two adjacent teeth that require separating. It is then folded back from lingual aspect to the buccal side over the contact point. The two ends of the wire are then wound slowly in a clockwise direction until the twisted part begins to wind on itself. The trimmed and the twisted tip is then neatly tucked away into the gingival embrasure. Brass wires are also left in the mouth for one to two weeks to obtain adequate separation - and upon removal of the wire, the twisted part is turned in an anticlockwise direction to untie it.

*Figure 26: Tooth separation with brass wire*



An efficient and consistent practice to adopt is to always tie wires in a clockwise direction and to untie them in an anticlockwise direction. Adopting this tying and untying procedure with all wire ligations will save much time and guesswork in the practice.

Currently the use of bondable tubes on the first and second molars have supplanted the use of bands. These are easier to place and cause less discomfort to the patient. However, bands form essential anchors in cases where auxiliary devices such as lip bumpers, headgear and TPAs or LAes are used.



*Figure 27: Molar bands*

### **Band placement**

Orthodontic bands are essentially SS rings of different sizes designed to fit around a wide range of tooth sizes. On the buccal aspect of the band is the buccal tube that has a hook to it, which in placement on the tooth, should project distally. The buccal tube design can be single tubed to accommodate only one wire or it may be multi-tubed to accommodate the use of auxiliaries such as a headgear or a lip bumper.

Before cementation, bands of an approximate size are selected and tested for appropriate fit. The selected band should fit snugly and finger tight with the mesial and distal occlusal margins of the band seated at the same level as the respective marginal ridges of the tooth. The hooks on the band tubes should always project disto-lingually. Once selected, the bands are carefully arranged in a row with the 46 as the first band to be placed followed successively by the 16, 36 and the 26. The assistant should then load the bands with cement in this order and cementation follows this sequence in order to avoid confusion and save time. Fluoridated cements are preferable; and either light or chemical cure cements may be used.

When loading, the band is held with a bracket tweezer at the buccal tube and the cement is neatly buttered on the inside of band. The loaded band is then handed to the doctor who will seat the band using a band pusher or a bite stick. Any excess flesh of cement that extrudes must be neatly removed before the cement sets.

If treatment necessitates that the bite be opened and the occlusion unlocked, the excess cement that spills from the band can be added to the occlusal surface of the functional cusp of the molar.

Always guard the ends of the band pusher with the tips of your thumb and index finger of your alternate hand to avoid slippage of the band pusher and possible injury to the patient.

A squirt from an air syringe and a dental probe may be used to open and maintain patency of the buccal tube before the cement sets.

If you do not anticipate using any attachments or headgear and lip bumpers, bands or buccal tubes with a single tube for the A/ws may be used. They are cheaper, less bulky and less bothersome to the patient.

This also applies to bands with cleats on the lingual aspect for the attachment of mechanical accessories.

Always be sure that the dimensions of the buccal tube matches the slot size of the brackets used in the practice.

If heavy forces are to be applied to the buccal tubes as is with the use of headgear or lip bumpers, use molar bands rather than bondable tubes, as the latter will debond with excessive force.

Once the bands are seated and before the cement sets, have the patient occlude gently on the bands or buccal tubes to ensure there are not any unintended occlusal interferences.

### **Bondable buccal tubes**

Bondable buccal tubes cost less than bands, are not as bulky as bands, are easier to place and less annoying to the patient. They also eliminate the need for tooth separation and can reduce the duration of the entire banding procedure a single visit. The method of bonding buccal tubes is the same as for any other bonding routine and consist of the following steps:

1. Clean the tooth surface.
2. Isolate the tooth.
3. Condition (apply acid etch) for 30 seconds – longer application time does not add to the bond strength.
4. Rinse.
5. Dry.
6. Paint the etched surface of the tooth and the base of the bondable buccal tube with primer.
7. Load bonding agent on the bondable tube specific for the tooth to be bonded. In placing the bondable tube on the tooth, the hook on the buccal tube must always be positioned disto-gingival to the tooth
8. Remove any excess bonding material around the attachment with a probe and allow a 2-minute set, or cure for 30 seconds with the UV light if light cured bond is used.



*Figure 28: A bondable buccal tube*

During the acid etch process, a selected area of tooth substance is prepared for bonding via the application of a corrosive agent (most commonly a solution or gel of 37% phosphoric acid). The effect is a removal of a small amount of less mineralized, inter-prismatic enamel and opening of pores between the enamel prisms, substantially enlarging the surface area of the bonded part so the adhesive can penetrate into the enamel, providing micromechanical retention.



*Figure 29: A curing lights*

In order to expedite the process, it is important to adopt a standardised operating procedure. Do one side of the mouth and then the other. Start with the right upper and lower quadrants first, followed by the left quadrants.

In communicating with your chairside assistant always use the term "conditioner" in the operatory instead of "acid etch" – it is less vexing to the patient.

Generally, bondable tubes on the molars are preferred to bands, particularly when secondary forces from a headgear and lip bumpers which can debond the attachments, will not be a component of the treatment.

When placing tubes on both first and second molars, be sure the tubes on the first molars are convertible, (i.e. that the buccal surface of the tube can be stripped away so it can function as a bracket). It would be difficult and even impossible to ream a firm, non-flexible wire through the tube on the first as well as the second molar without having a molar tube debond.



*Figure 30: A convertible buccal tube*



*Figure 31: A converted buccal tube*

## Chapter 4

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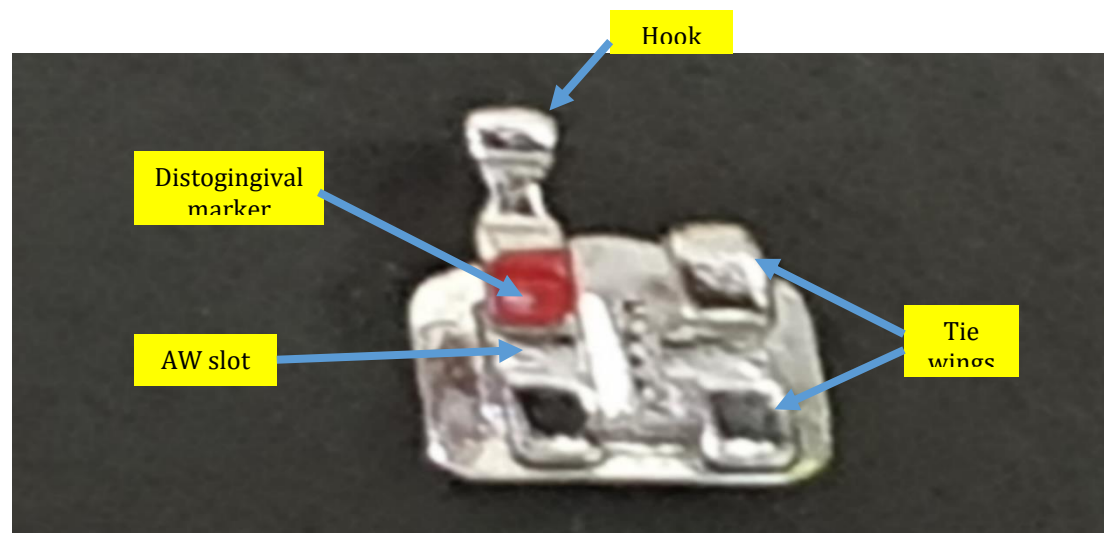
### Brackets and bracket systems

There are a variety of orthodontic attachments that can be fixed to a tooth. These may vary from a bondable tube as mentioned earlier, an orthodontic button, an orthodontic bracket; or a piece of wire that may serve as a splint or a fixed retainer.

An orthodontic bracket is an attachment, -usually made of SS which is fixed to a tooth, and by engagement of a wire to it, constitutes a bracket/wire alliance referred to as the fixed orthodontic appliance (FOA). This mutual relationship implies that any force applied to the wire will be expressed in the bracket that is attached to the tooth crown and will ultimately be dissipated by the biological housing of the tooth causing the tooth to move.

The face of the bracket has a horizontal slot for insertion of an AW. Surrounding the bracket slot are tiny projections on the 4 corners of the bracket slot referred to as tie wings which serve as attachments for ligatures to secure the wire to the bracket.

The back of the bracket or bracket base has a roughened surface enabling fixation of the bracket to the tooth. Bracket bases have a roughened surface, which may be due to either a wire mesh or etched lathe cut channels.



*Figure 32: Bracket face*



*Figure 33: Mesh and lathe cut bracket bases*

The bond strength between bracket base and tooth should be in the range of 6 to 8 MPa (mega Pascals). At the end of treatment the FOA needs to be removed. A strong bond may complicate this procedure and cause enamel fractures, while a weak bond can result in premature bracket debonds during treatment. There is also no difference in bond strength between mesh based and lathe cut bracket bases.

A bracket slot houses the AW and the slot on a bracket may either engage the wire along the vertical plane as does the Begg bracket or on the horizontal plane as seen in most contemporary brackets. The latter are referred to as 'edgewise' brackets.

A tie wing is a globular extension of the bracket above and below the four corners of the slot for securing either an elastic ligature (EL) or a SL that will engage and retain the AW in the bracket slot.

Orthodontic brackets are available in different designs, some of which are listed below:

1. The Begg bracket – has a single vertical entry slot for insertion of the AW and a lock pin to keep the AW in position.
2. The Alexander bracket – has a horizontal or edgewise slot with two single tie wings, one above and one below the bracket slot.
3. The Siamese or twin bracket – also has an edgewise slot but has four tie wings, hence the moniker 'twin bracket'.
4. The Tip edge bracket, like the Alexander bracket also has only 2 tie wings with an edgewise slot that is designed to allow teeth to tip easily before full thickness wires can be engaged to finalise tooth positions.

5. Self-ligating brackets – these are edgewise brackets that have a metallic gate attached to the bracket to lock the AW into the bracket slot eliminating the need to fix the wire to the bracket slot with ELs or SLs.
6. Lingual brackets – these are specialised brackets that are placed on the lingual surface of teeth making the fixed appliance unobtrusive.

Brackets are usually made of SS which offers less frictional resistance to the SS AW.

While tooth coloured brackets may serve the aesthetic needs of some patients, these brackets have a high frictional resistance with the SS AWs which may extend treatment time. These brackets are also not easy to remove at the end of treatment and can result in enamel fractures. Patients should be made aware of this when requesting tooth coloured brackets.



*Figure 34: A tooth coloured bracket*



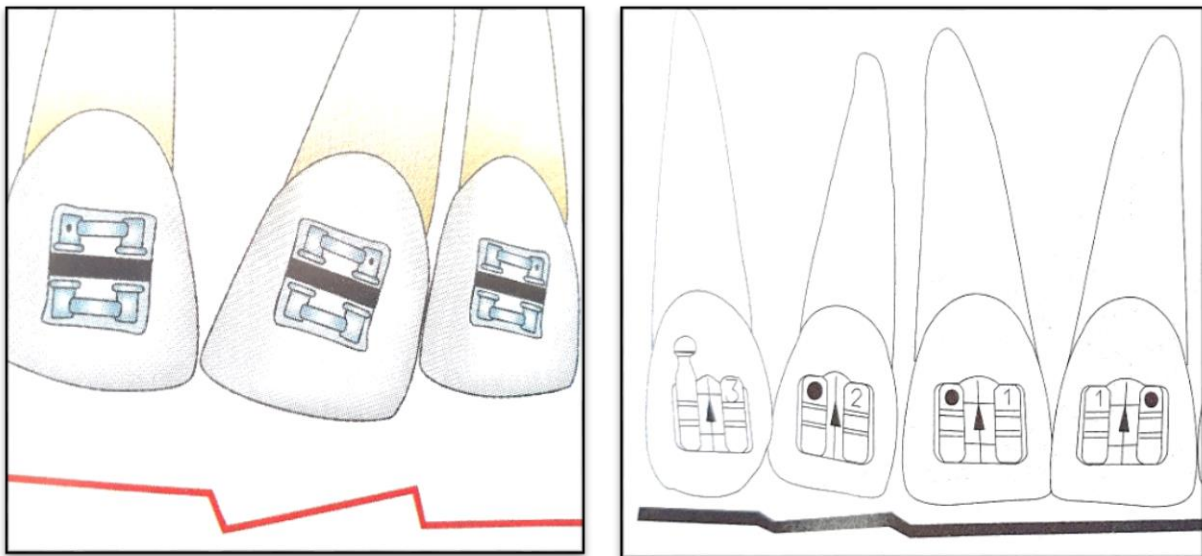
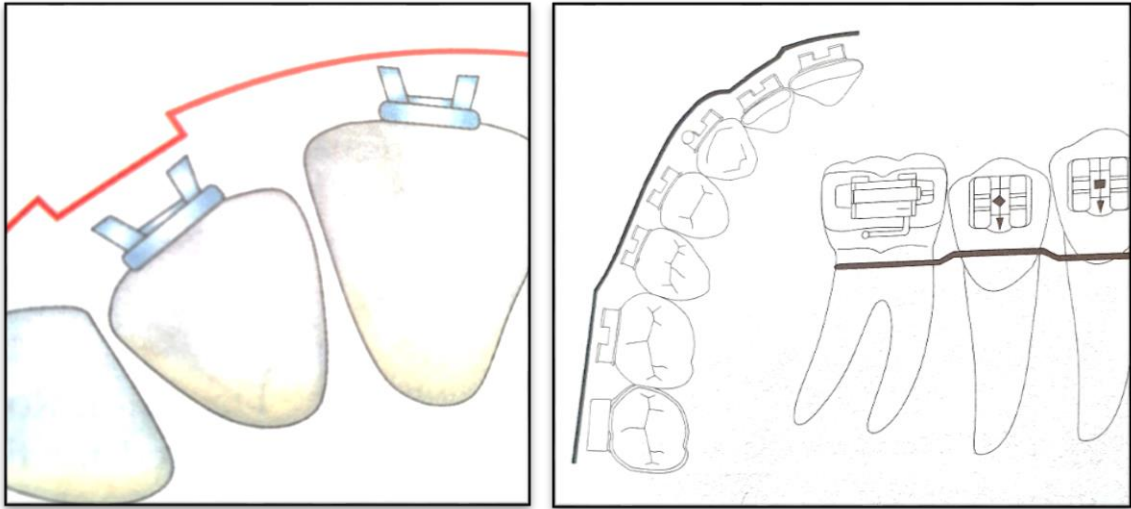
*Figure 35: Lingual brackets*

### **Bracket Prescriptions**

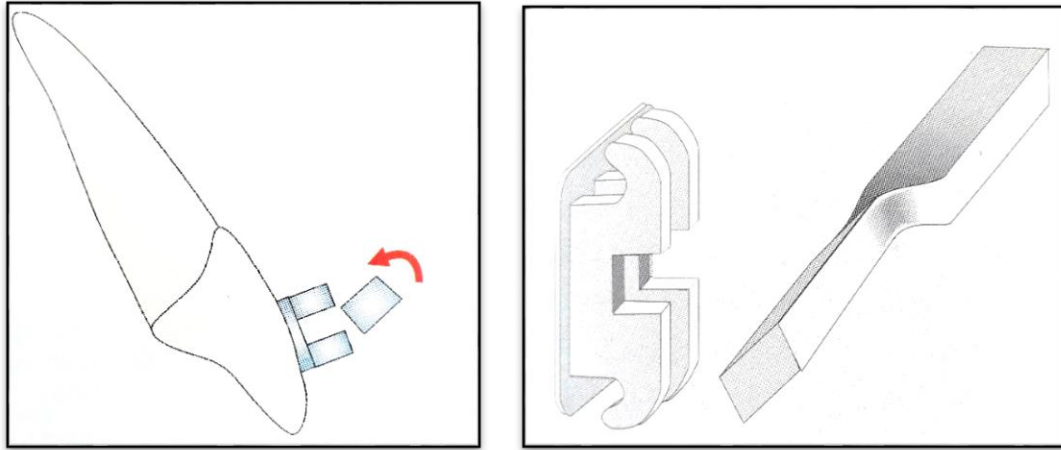
The prescription of a bracket defines the magnitude of the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> order bends i.e. inherent in/out position of the buccal tooth surface, the amount of tip (mesio-distal crown position) and the amount of torque (bucco-lingual root position) that a bracket will exert on a tooth. Brackets having these built in adjustments are referred to as pre-adjusted edgewise brackets. Prior to the advent of these brackets, 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> order bends had to be meticulously bent into the AW which was then engaged into what is referred to as standard edgewise bracket, - so as to achieve the desired in/out position, tip and the torque of each tooth. Unlike the standard brackets of the past, pre adjusted brackets have the in/out slot positions, tip and torque built into the bracket eliminating the need for intricate wire bends. Use of the pre-adjusted edgewise brackets constitute the 'straight wire appliance' as it eliminates the need for regulatory adjustments in the AW.

A bracket prescription therefore defines the amount of tip and torque contained in each bracket for every tooth in the mouth and these values will vary among bracket designs and manufacturers. The bracket prescription indicates how, and to what value the three bends are contained in the bracket, which in turn dictate the ultimate tip, torque and bucco-lingual position of a tooth.

*Figure 36: First order bends*



*Figure 37: Second order bends*



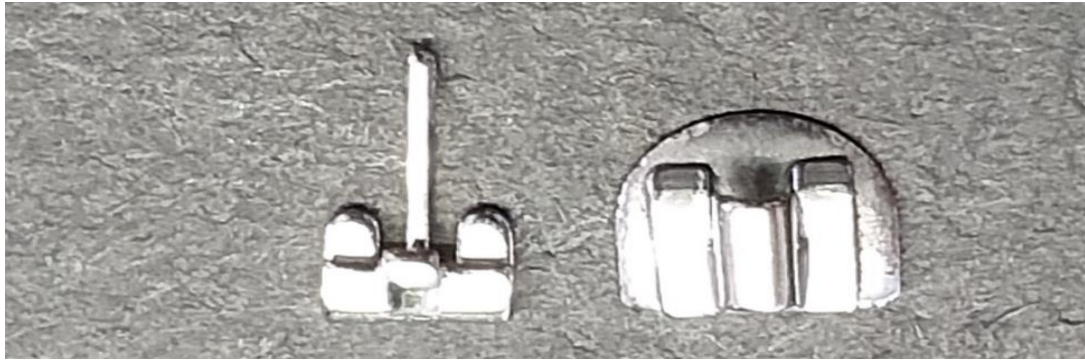
*Figure 38: Third order bends*

In summary, first order bends determine the in-out or bucco-lingual position of the crown. Second order bends determine the mesio-distal tip of the crown while third order bends will determine the bucco-lingual position of the root (often referred to as the torque).

For maximum expression of these three bends and in order to obtain full benefit from any prescription it is vital that the final AWs in the treatment process engage and occupy the full depth and width of the bracket slot.

It is generally not good practice to use brackets of different prescriptions on the same patient as this may affect the final tooth position.

The Begg prescription uses brackets that are specific for the Begg technique. Begg brackets have a vertical entry slot which houses the AW and a vertical tube into which fits a malleable brass pin to lock the AW into position. The Begg technique employs round arch wires as the bracket does not possess any tip, torque or in/out capabilities. Hence the functional efficacy of the Begg appliance demands intricate wire bending skills and makes the system limited in the hands of the inexperienced. However, the mechanical principles employed by this technique are fundamental and can be applied and employed to other bracket prescription systems.



*Figure 39: A Begg bracket with a locking pin to secure the AW*

While the technique may be intricate, the Begg bracket, because of its relatively low cost, can serve as an economic intermediate for the transitional movement of a single tooth.

The Alexander bracket is a pre-adjusted edgewise bracket that has only two tie wings for the attachment of ligatures. The base of the slot has adjustable microplates that extend mesially and distally beyond the perimeter of the bracket. These extensions or wings are malleable and can be elevated or depressed to increase or decrease a force against the AW, which would express as a rotational change in the position of the concerned tooth.



*Figure 40: An Alexander bracket*



*Figure 41: A tip edge bracket*

By far the most popular bracket in use is the pre-adjusted twin bracket. These brackets are produced by several manufacturers and are available in different prescriptions.

While a prescription of a bracket or the appliance defines the magnitude of the 3 order bends of the bracket, slot dimensions denotes the actual width and depth of the bracket slot into which the wire fits. Generally, bracket slots come in 2 sizes namely a 0,018 X 0,028 inch and a 0,022 X 0,028 inch where 0,028 inch is a measure of slot depth and the first variable a measure of slot height. Bracket prescriptions are available in any of the 2 slot sizes and for full expression of torque, the final AWs must be of such dimension to engage the entire bracket slot. Thickness of the final AWs will therefore be dictated by the size of the bracket slot, and the slot size of the brackets employed by the practice will determine the AW requirements of the practice.

Slot sizes should not be mixed on a patient, as the final arch wires will not fit uniformly into the bracket slots and buccal tubes.

It is prudent to use a uniform slot size as it makes for easier inventory control. Also ensure, the dimensions of the molar tubes are the same size as the slot size of the brackets.

*Table 1: Common bracket prescriptions (expressed in degrees)*

<b>Tip</b>							
<b>Upper MBT</b>	4	8	8	0	0	0	0
<b>Roth</b>	5	9	13	0	0	0	0
<b>Andrews</b>	5	9	1	2	2	5	5
<b>TEETH</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>
<b>Lower Andrews</b>	2	2	5	2	2	2	2
<b>Roth</b>	2	2	7	-1	-1	-1	-1
<b>MBT</b>	0	0	3	2	2	0	0
<b>Torque</b>							
<b>Upper MBT</b>	17	10	-7	-7	-7	-14	-14
<b>Roth</b>	12	8	-2	-7	-7	-14	-14
<b>Andrews</b>	7	3	-7	-7	-7	-9	-9
<b>TEETH</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>
<b>Lower Andrews</b>	-1	-1	-11	-17	-22	-30	-33
<b>Roth</b>	-1	-1	-11	-17	-22	-30	-30
<b>MBT</b>	-6	-6	-6	-12	-17	-20	-10

A positive tip value implies that the crown will be mesial to the root and the opposite is true for a negative value. A positive torque value implies that the root lies lingual or palatal to the crown and vice versa for a negative value.

Self-ligating brackets are also a pre-adjusted appliance system available in different prescriptions and slot sizes. These brackets cost more and do not require ligature changes at the recall appointments. While the use of this appliance system may reduce the amount of recall visits during treatment, there is no evidence that self-ligating brackets reduce the total treatment time when compared to other bracket systems.



*Figure 42: A self-ligating bracket*

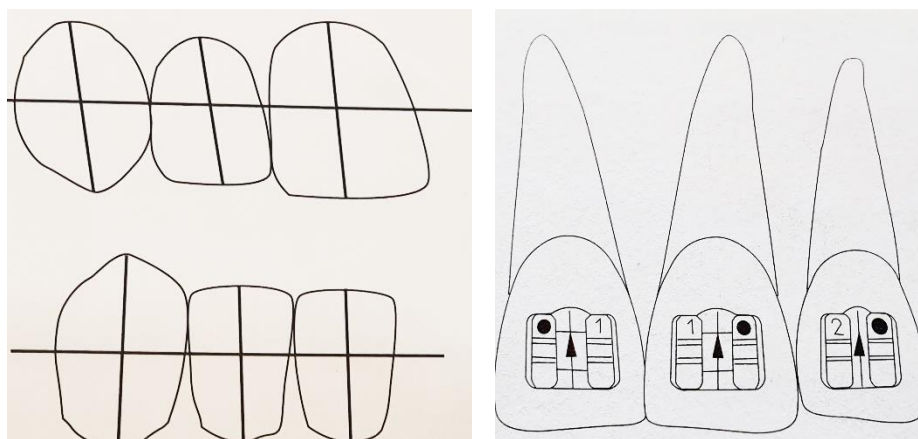
## Bracket position and placement

Ideally a bracket should be placed in the middle of the clinical crown:

- Along the long axis of the tooth
- Parallel to the incisal or occlusal edge
- In the occluso-gingival centre of the tooth
- And in the mesio-distal centre of the tooth

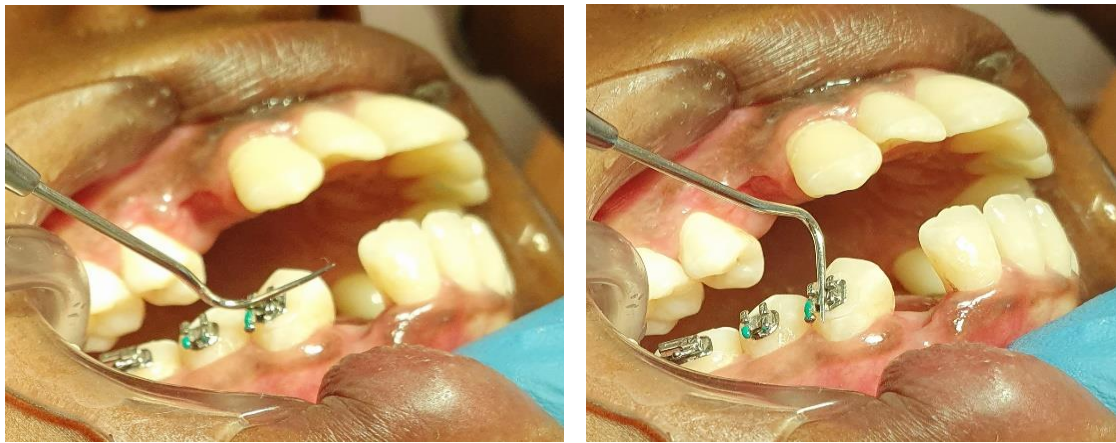
Variations and modifications in bracket position will be influenced by the following factors:

- The tooth position
- The tooth length
- The crown rotation
- The crown tip
- Gingival and periodontal health



*Figure 43: Bracket locations and labels*

In placing a bracket one should visualise the final position of the tooth in relation to the dental arch and the face.



*Figure 44: Horizontal and vertical alignment of a bracket*



*Figure 45: Positions of a brackets on teeth*

Always remember - to keep the end in mind and treat toward that end. Bracket positions can first be marked on a set of study casts of the patient to enable accurate and confident clinical replication.

A bracket positioning gauge such as a "Wick stick" can serve as a useful guide in positioning a bracket. The width of the gauge tips must match the width of the bracket slot in use.

Buccal tubes are placed in the crown centre and parallel to the buccal occlusal edges on molars irrespective of the tooth position at the commencement of

treatment. Ensure that there is no contact of the buccal tube with the opposing tooth before curing the bonding material.

Always use convertible buccal tubes on the first molars, particularly when the second molars will be bonded at a follow up visit.

## **Bracket bonding**

The time required for the bracket bonding procedure can vary from 30 to 60 minutes depending on operator experience and efficiency of the procedure. All general dental treatment should be completed and the patient's teeth should be free of any plaque before the procedure commences.

1. Position and place cheek and lip retractor.
2. Bend a flexible clear suction tube into an 's' form and let patient bite with the posterior (preferably the 7's or 8's) on the distal end of 's'. The mesial end of the 's' shaped tube will be connected to the suction pipe and the distal or terminal point will be wedged between the posterior teeth with the tip located in the distobuccal sulcus area.

When working on the right half of the patient's mouth the patient's head will be tilted to the left and the suction tube will enter the patient's mouth from the right side with the suction tip positioned in the left distobuccal sulcus where it will collect fluid in this area and not interfere with the working area on the right side.

When working on the left half of the patient's mouth the patient's head will be tilted to the right and the suction tube will enter the patient's mouth from the left side with the suction tip positioned in the right distobuccal sulcus where it will collect fluid that pools in this area and not obstruct the working area on the left side

As confidence in the procedure improves the need to change the suction tube from left to right sides may become pointless.



*Figure 46: Suction tube in an's' bend*



*Figure 47: Lip retraction with suction tube in position*

3. Position the suction tube appropriately.

4. Rinse and air dry all the teeth.
5. Dip a small delivery brush in a petri dish containing acid etch gel and paint it on a defined area of each tooth to be bonded starting on the 46 followed by the 45, 44, 43 until the 36. Immediately do the same from the 26 all the way back to the 16. This is referred to this as the 'return c route'. In cases requiring only one arch bonding it is termed the 'single c route'. Use a coloured acid gel instead of clear etching fluid. It allows for visible and precise placement of the etchant on a desired spot of the tooth and avoids waste and seepage of the etchant to the surrounding tissues.

Also use different coloured petri dishes for the acid etch gel and for the primer fluid.

6. Condition (etch) for 15 to 20 seconds, rinse, then dry and repeat following the same 'c' route as described in step 5 above.
7. Lightly paint some primer on each tooth using the 'return c route'. Excessive primer on the tooth will cause the bracket to slide on the tooth surface into undesirable positions.
8. Have your assistant paint primer and load bonding agent on each bracket and then carefully position it on the centre (occlusogingivally and mesiodistally) of the tooth.
9. Press the bracket firmly against the tooth with a probe maintaining the ideal bracket position mentioned above and carefully remove any extruding and residual bonding flesh with the same dental probe without disturbing the desired bracket position.
10. Do the same with all subsequent teeth on the 'return c route'.
11. Once all the teeth are done and bracket positions on the tooth have been confirmed, the bonding agent can be cured with a UV light if light cure bond is used or wait for 5 to 10 minutes if a chemically cured bonding agent is used, before loading and tying in the A/Ws.

Excess bonding flesh retains plaque and stains with time and must be removed before curing. It can also lodge between the tie wings of the bracket and the bracket base obstructing the engagement of elastic or steel ligatures. If this occurs, then careful use of a tapered fissure bur can be used to unclog the tie wing.

Bonding material may be dispensed as a powder/liquid mixture or as a premixed paste in a syringe. The bonding paste may either be chemical cure, light cure, or a combination of the two.

It is advisable for newcomers to the procedure to initially use a light cure bond, and as the operator's confidence with the technique improves, to change over to the less costly chemical cure bonding material. Light cure bonding is however a great time saver for the replacement of debonded brackets.

Premixed light cure pastes are dispensed in black syringes that are used with their accompanying primers also dispensed in black bottles, while chemical cure material is dispensed in clear containers.



*Figure 48: Light and self-cure bracket adhesives*



*Figure 49: Colour coded petri dishes and brushes*

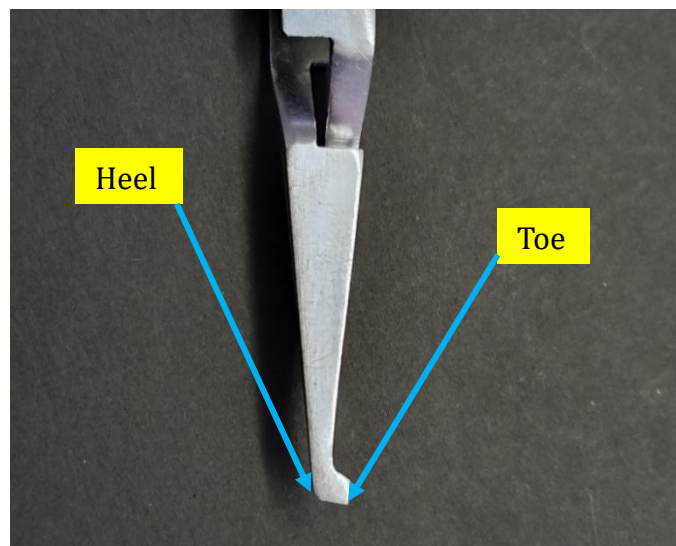
### **Bracket handling**

A twin winged orthodontic bracket has a central horizontal slot surrounded by undercut extensions at each of the four corners of the slot referred to as 'tie wings'. The central slot houses the AW and the four tie wings act as connectors for either SIs or ELs, which secure the AW into the bracket slot. There are two gingival and two occlusal or incisal wings. For ease of identification and manipulation, the tie wing that has a marker by way of either a colour, a pit or an engraved tooth number is positioned on the disto-lingual tie wing of the bracket and must hold that same position when placed on the intended tooth. Brackets are usually dispensed on a tooth labelled card in kits of 20 brackets consisting of upper right second premolar through to lower left second premolar, for ease of placement on specific teeth.



*Figure 50: Brackets on a dispensing card*

A bracket tweezer is used for handling brackets and tubes during the bonding procedure. The end of bracket tweezers bears resemblance to a golf club – it has a toe and a heel. The toe constitutes the tip, while the heel joins and merges with the bracket handle.



*Figure 51: A toe and heel of a bracket tweezer*



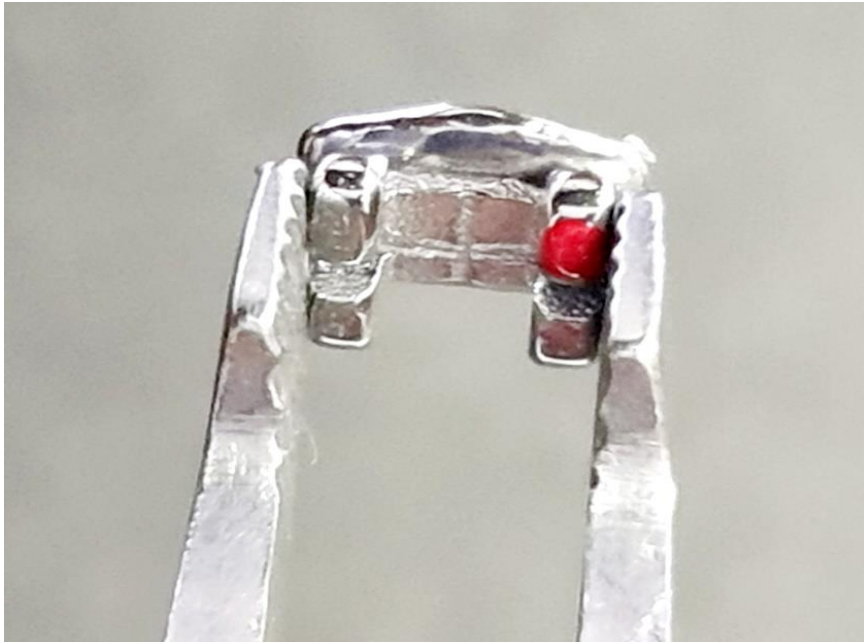
*Figure 52: Different tweezer tip designs*

To standardise and expedite the bracket bonding procedure, the following routine may be employed:

The bracket is always collected off the bracket card with the bracket tweezer in such a way that the distolingual marker on the bracket is at the level of the tweezer toe. For the lower arch the loaded bracket tweezer is then handed to the operator with the toe pointing away from him/her. For the upper arch the loaded bracket tweezer is handed to the operator with the toe facing him/her. This makes for quick and easy placement of the bracket on specific teeth with ease as to the dental quadrant and bracket orientation.

Both bondable tubes and brackets are attached using the 'return c route' commencing with the molar tube on the 46. This method will eliminate any confusion and doubt in bracket selection and placement, save time, and program a standard operating procedure. The procedure should have an operating theatre likeness to it whereby the operator merely puts out his/her hand, which is loaded by the assistant with the necessary instrument and material for the banding procedure.

It is efficient to use two bracket tweezers for the bonding procedure. While the operator is positioning the one bracket on a tooth, the other bracket tweezer is being loaded with a successive bracket and bonding material by the assistant.



*Figure 53: A tweezer loaded with a bracket*

Positioning of the tubes on the molars can be complicated and it is important to ensure that the position of the buccal tube is free of the occlusion. The assistant should therefore not rush but delay the preparation of the successive bracket until the operator is satisfied with the placement of the tube on the molar.

Because access to these areas is restricted and for ease of the procedure and patient comfort, it is prudent to bond buccal tubes to the upper and lower second molars at a subsequent recall visit. It is also advisable to bond the molars individually using a light cure adhesive.

Unless the patient needs surgery followed by inter arch fixation or elastics, it is not necessary to acquire or use brackets with hooks on premolars. They are bulky, cost more, attract plaque and add to discomfort of the FOA. However, hooks on the canine brackets are useful as they can assist a variety of supplementary functions of fixed appliance therapy.

## Chapter 5

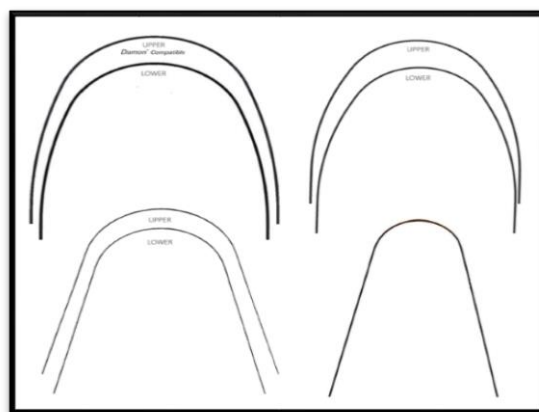
### Orthodontic Wires

Orthodontic tooth movement is the result of an alliance between a bonded bracket and an AW.

#### AWs

AWs are available in different shapes and sizes and are made of different material. The more common types are: the Bonwill Hawley arch (constructed around an equilateral triangle); the Catenary curve (formed by the length of a chain held at each end and allowed to drop); the Brader arch (similar to a catenary curve but tapering inwardly in the distal areas). A simple AW treatment sequence to follow is:

1. Initial wires – usually round nickel titanium (NiTi) wires which are flexible, elastic wires that retain their arch shape.
2. Intermediate wires – stainless steel (SS) wires of sizes between 0,014" round to 0,016X0,022" square
3. Finishing wires – these are usually square firm SS wires their thickness of which should match the bracket slot size for full engagement to optimally express the torque (third order bend) built into the bracket. These wires are supplied in preformed arch shapes, - and it is important to adjust the shape to conform to the specific arch shape of the patient.



*Figure 54: Different shapes of preformed AWs*

Irrespective of the arch type used, the arch form specific to the patient must always be respected and maintained throughout the treatment as any undue expansion or contraction will result in relapse (i.e. a return to the original malocclusion).

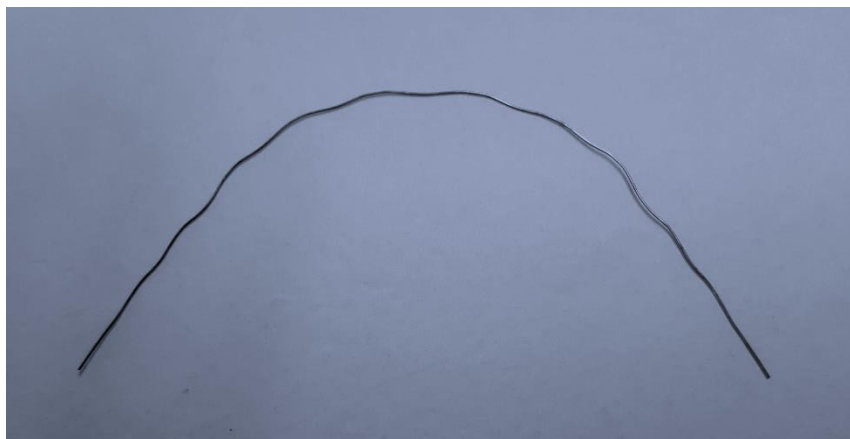
Depending on the severity of the malocclusion the initial wire can vary between a 0,012" and a 0,016" round NiTi wire. Often a 0,012" NiTi wire may be the only initial wire that is needed. In a Class I malocclusion with minor crowding one could commence with a 0,016X0,022" square NiTi wire.

When used as the initial wire, a thick wire may not be flexible enough to engage the brackets on severely malposed teeth and may result in bracket debonds.

Mild crowding may be defined as a 2-4mm space shortage, moderate as a 4-8mm shortage and a deficit of 8-12mm is defined as a severe space shortage.

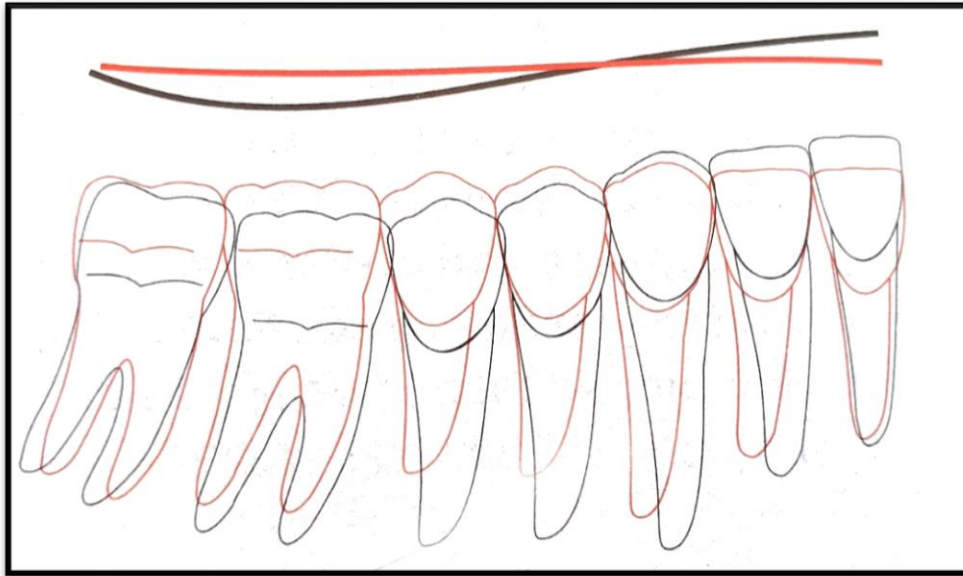
After an initial wear of 3 to 6 months the first NiTi wire should be removed and inspected. It should have a smooth and uniform outline resembling a new wire and not have multiple bends or kinks reflective of the malposed position of the teeth from which it was removed.

Quality NiTi AW should move teeth to conform to the shape of the wire and the wire should not take on the shape of the malposed teeth in the arch.



*Figure 55: An ineffective NiTi that has deformed*

The purpose of the initial AWs is to level the arch in totality, i.e. upon removal of the last of the initial wires, the brackets should all be neatly aligned on the same horizontal plane to allow placement of the intermediate wires with ease. This process may require gradual progression from a 0,012" to a 0,016" NiTi over a period of a few visits. One should not be hasty to change the AWs too soon as a high quality 0,012" NiTi wire can often express all the levelling that is necessary for the initial phase. Depending on the severity of the malocclusion, the levelling phase may take six to nine months.



*Figure 56: Levelling of the dental arch*

Recall visits are usually done over six to eight week intervals and patients with self-ligating brackets can be even be seen at ten week intervals.

Intermediate wires are the 0,016"SS, 0,016X0,016"NiTi, 0,016X0,016"SS and the 0,016X0,022"NiTi and SS wires. The 0,016"SS round Special Plus Australian wire is a resilient and versatile wire that is effective for sliding mechanics (i.e. moving one tooth at a time along the AW). This wire can readily be bent to replicate the arch shape or incorporate different bends and loops that enhance the efficacy of the fixed appliance.

The low elasticity of a SS wire will not buckle as would a NiTi wire under the same force. Teeth are more likely to move on a firm straight SS wire which offers less frictional resistance than they would on a flexible and bent NiTi wire.

Australian wire is dispensed on a reel in different textures and thickness, and the 0,016" Special Plus Australian wire is flexible, easy to handle and does not break or peel with intricate manipulation.



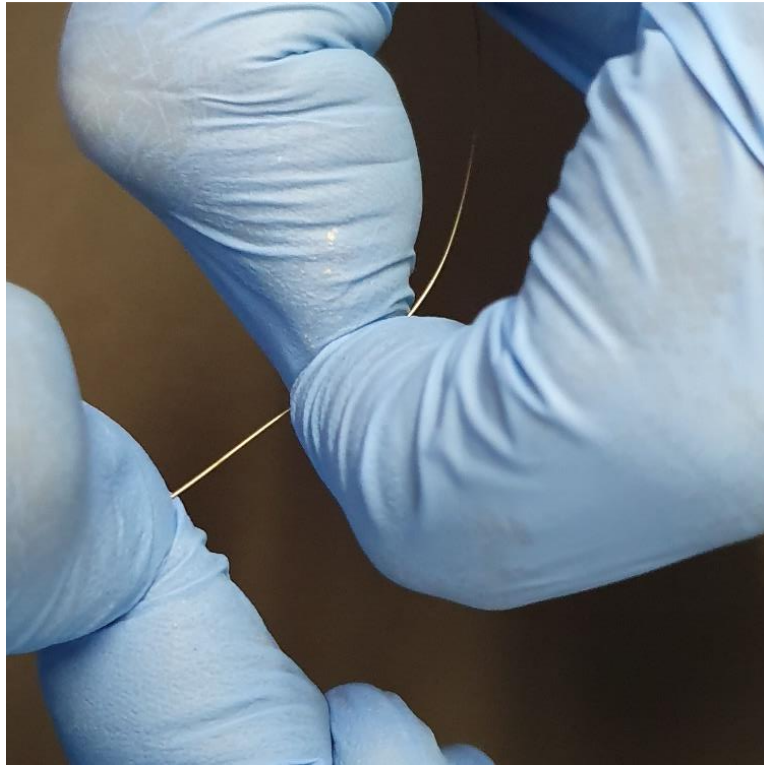
*Figure 57: A reel of 0,016" Special Plus round Australian wire*

### **Wire placement**

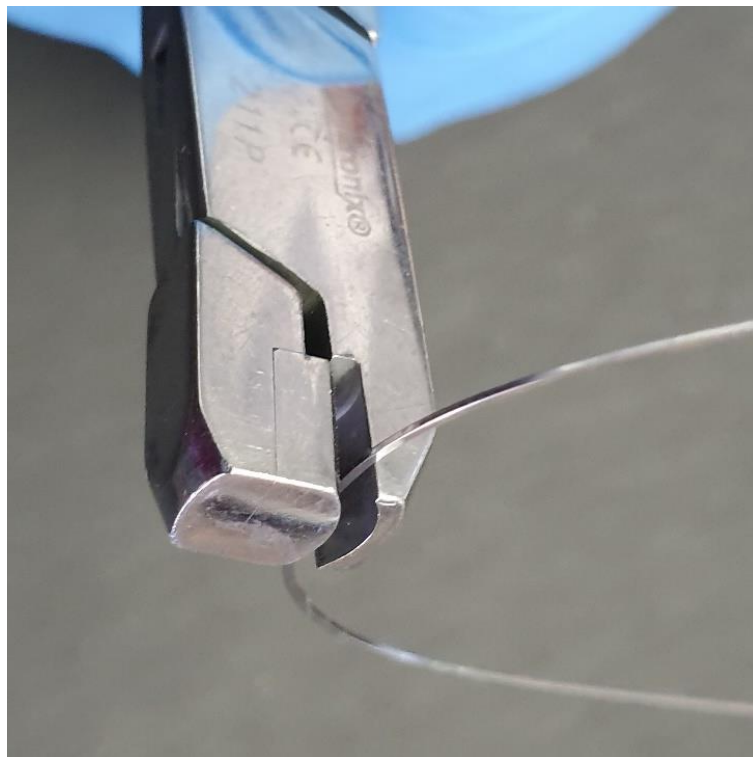
Ideally, the first AW to be engaged in the bracket slots should be a thin soft flexible wire that is comfortable for the patient and can easily attached to the brackets on malposed teeth without causing any bracket debonds. Thicker wires will exert too much force, may elicit pain, retard movement and are prone to debond brackets. Before placement, the width of the AW should be adjusted to its intended size and the wire length should be reduced to the approximate size of the arch to avoid piercing the buccal tissue distal to the last tooth when loading the AW into the brackets and buccal tubes.

To reduce cost and inventory, it may be prudent to purchase only lower AWs as these can readily be expanded by finger moulding or with an arch forming plier to conform to the size of the arch. It is also prudent to acquire quality wires.

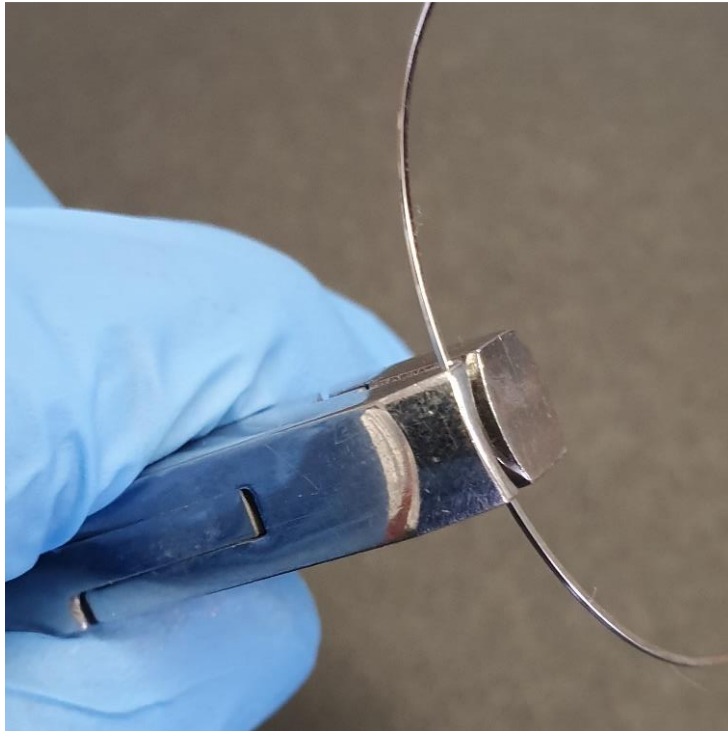
Crossbites can develop as a complication of incorrect upper and lower AW coordination. AWs should therefore be carefully coordinated for the intended movement and always conform to the specificity of the patients' dental arch.



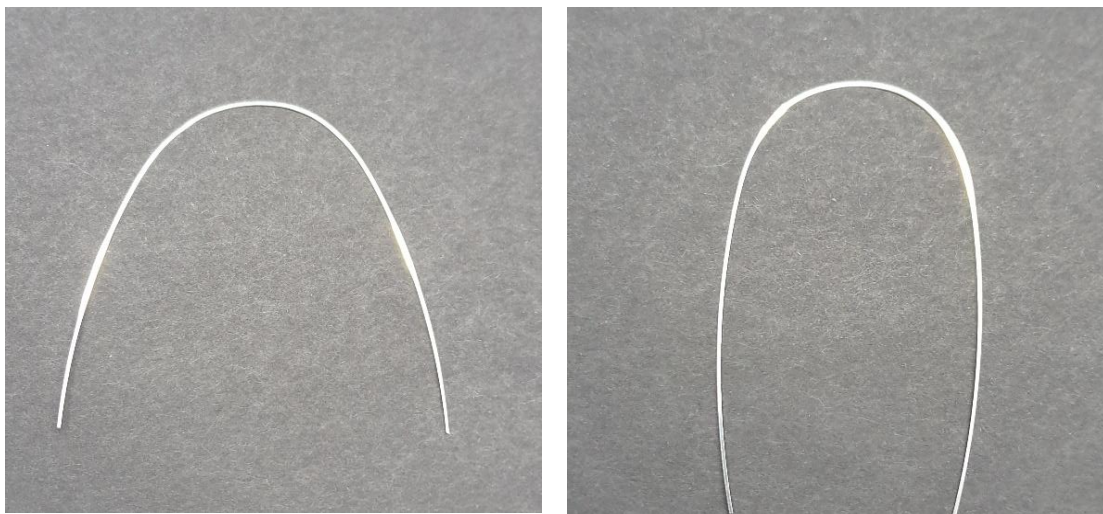
*Figure 58: Finger moulding of a Niti AW to alter its size*



*Figure 59: Moulding an AW with an arch forming plier to enlarge it*



*Figure 60: Moulding an AW with an arch forming plier to constrict it*



*Figure 61: Confirming wire flatness of expanded and constricted AWs*

Once selected and modified to conform to the patient's specific arch, the AW is then positioned over the bracket slots and the distal ends of the wire are reamed through the buccal tubes on the molars either manually or using a Weingart plier.

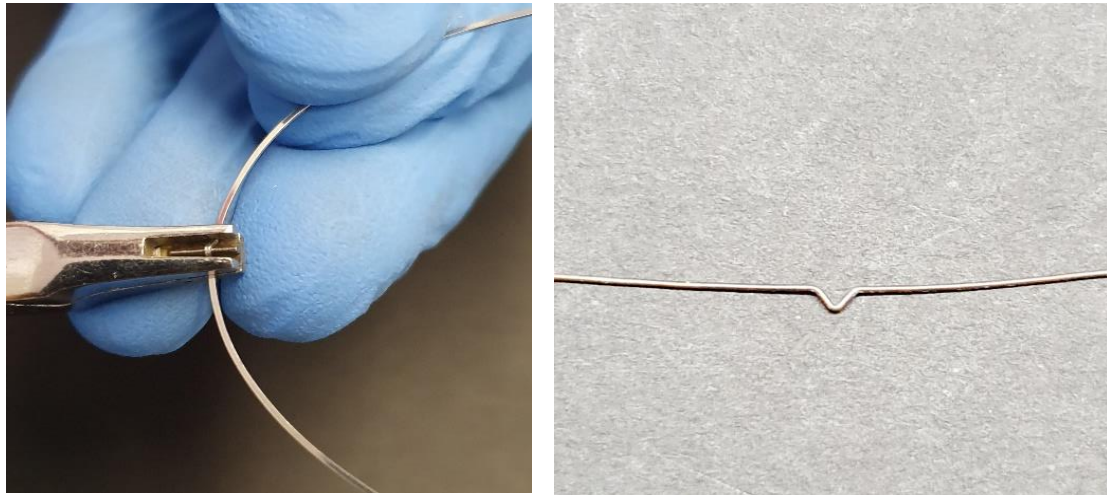
Working in a confined space with a soft and flexible NiTi wire may complicate the engagement of the wire ends into the molar tubes. To avoid this and stabilize the AW, an EL can be used to tie the AW to an incisor bracket.

The wire placement and ligation process is the same for both arches, however, the ligation procedure should commence in the lower arch, as brackets on this arch would have had a longer setting time making it less likely to debond which is, reassuring for the operator and less vexing for the patient.



*Figure 62: Loading an AW into the buccal tube with a Weingart plier*

In order to correct or avoid any midline asymmetries, the AW must be positioned in the anatomical midline of the dental arch and face. The centre point of the AW can usually be identified either by a visible mark or a kink in the wire produced by the manufacturer. If absent, it can also be manually added to the AW.



*Figure 63: Placing a central stop in an AW with a stop forming plier*

Thicker square wires may be cut at an angle so that the wire tip has an outer bevel which can assist with entry into the buccal tubes on the molars.



*Figure 64: Bevel cut on an AW for easy entry into the buccal tube*

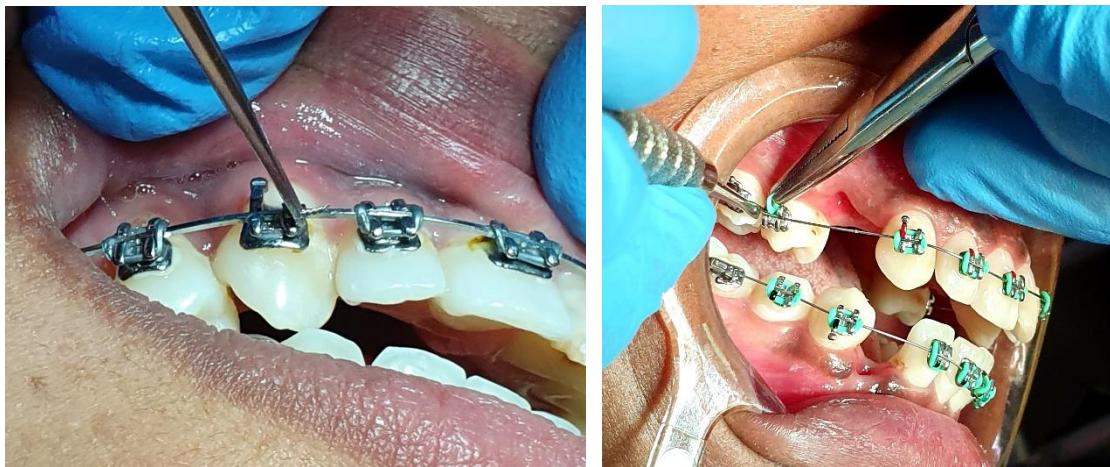
Because the return c bonding procedure commences in the lower arch the bracket bond in this arch would have had a slightly longer time to set and brackets are less likely to come loose if self-cure bonding material has been used. Bracket ligation should therefore commence in the lower left quadrant and proceed in accordance with the return c route.

The AWs are then locked into position with ELs starting in the lower arch from the right lower central incisor (41) to the right lower second premolar (45) followed by the left lower central incisor (31) to the left lower second premolar (35); and in the upper from the left upper central incisor (21) to the left upper second premolar (25) followed by the right upper central incisor (11) to the right upper second premolar (15). A ligature tucker is an indispensable

instrument to position and hold the wire in the bracket slot while the ligature is placed over the bracket tie wings. Ligatures are first engaged under one tie wing and then gently rolled over the remaining three tie wings - one wing at a time.

When using self-cure bonding material it is advantageous to ligate the wire in quadrants corresponding to the return c route to allow adequate curing time for brackets that have been placed in the return c sequence. The ligation process should however commence from incisors to molars in order to keep the AW centralized and maintain arch symmetry.

*Figure 65: Using a ligature tucker to seat and ligate an AW into a bracket slot*

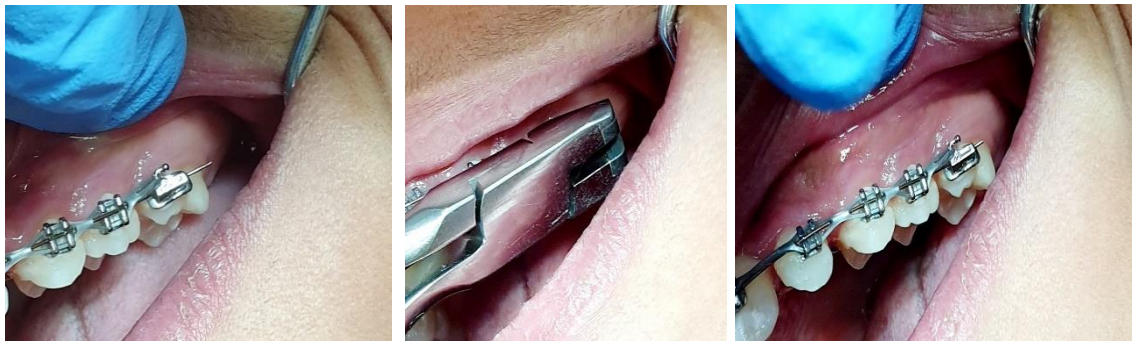


*Figure 66: Securing the wire in a bracket slot with an SL*

When ligating the first AWs in the treatment process or ligating the wire to a rebonded bracket, it is advisable to pre-stretch the ELs for ease of attachment to the tie wings. It also reduces the force on the bracket during ligation and limits the possibility of a debond.

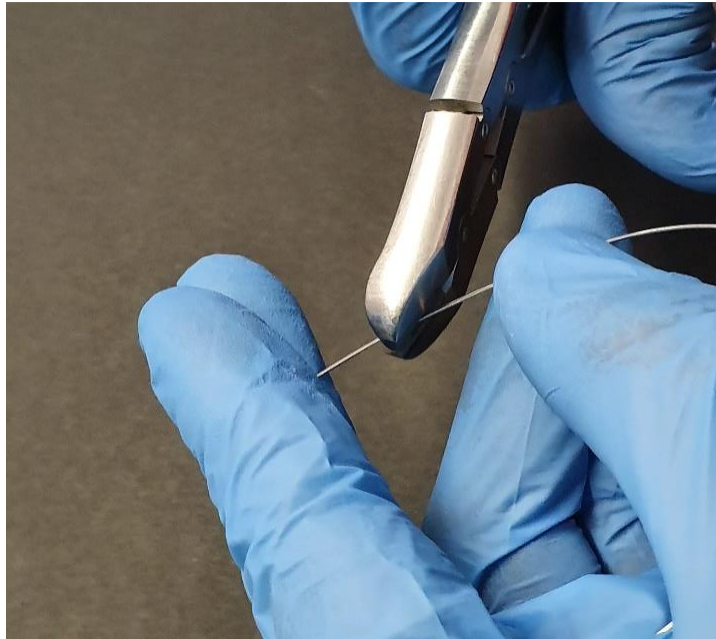
Depending on the severity of the malocclusion, the first AW once engaged may have a roller coaster appearance. It is essential therefore to commence with thin flexible 0,012" NiTi wires. If teeth are not severely malaligned one could commence with a 0.014" or even a 0.016" NiTi wire.

Once all ligatures are attached, the distal ends of the AWs that extend beyond the buccal tubes on the last molars must be neatly trimmed with a distal end cutter as close as possible to the ends of the buccal tubes. Untrimmed wires will be uncomfortable and traumatic to the patient, necessitating an additional emergency visit to reduce the distal projecting ends of the AW.



*Figure 67: Trimming the distal ends of a wire with a distal end cutter*

Extrorally, wires can be cut with a general heavy duty plier and wire cutting should be executed with caution to avoid harming the patient, operator or the assistant. Intraorally, a wire must always be cut with a distal end holding cutter and the operator must ensure that the distally cut piece of wire is always safely removed from the patient's mouth.



*Figure 68: Extraoral sectioning of a wire using a hard wire cutter*

Care should be exercised during intraoral reduction of the distal ends of the wire that extend beyond the buccal tubes. The distal end cutter should not be held too close to the buccal tube as the tube may debond when the plier beaks are closed.

Wax should be dispensed to the patient after the procedure and its use demonstrated to the patients to initially cover any irritating projections. Patients should be also be warned that indiscriminate and inappropriate use thereof may cause brackets to debond.

Always use new brackets to replace debonded brackets and have patients bear the cost thereof. Bracket breakages tend to decrease when patients are obliged to pay for repairs. Charges for bracket repairs should be included as a clause in the patients' consent agreement.

Verbal and written instructions must be given to the patient before they are discharged. A sample of an instruction leaflet is contained in the addendum.

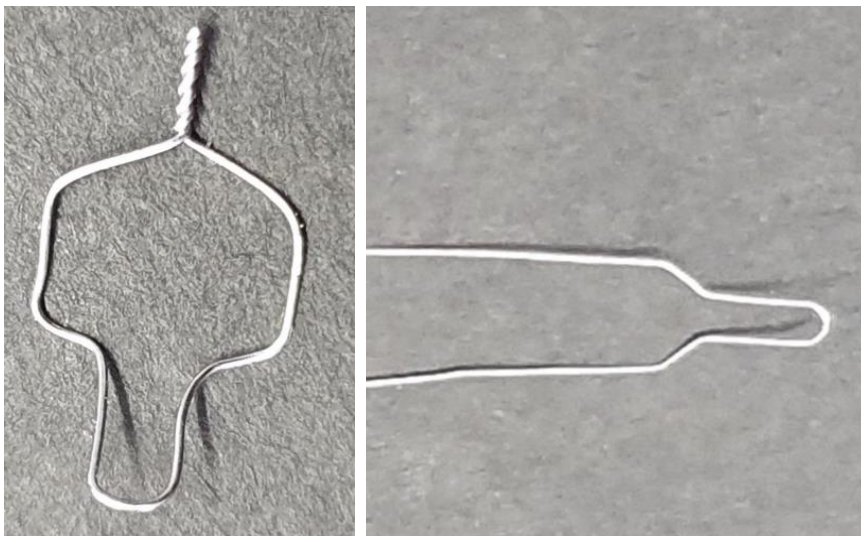
## **Ligatures**

Ligatures are used to engage and retain the AW in the bracket slot. There are essentially two types of ligatures namely:

1. Elastic ligatures (EL)
2. Steel ligatures (SL)



*Figure 69: ELs*



*Figure 70: SLs*

ELs come in different colours and their thickness and elasticity varies among manufacturers. They are often referred to as 'donuts' because of their resemblance to ring donuts.

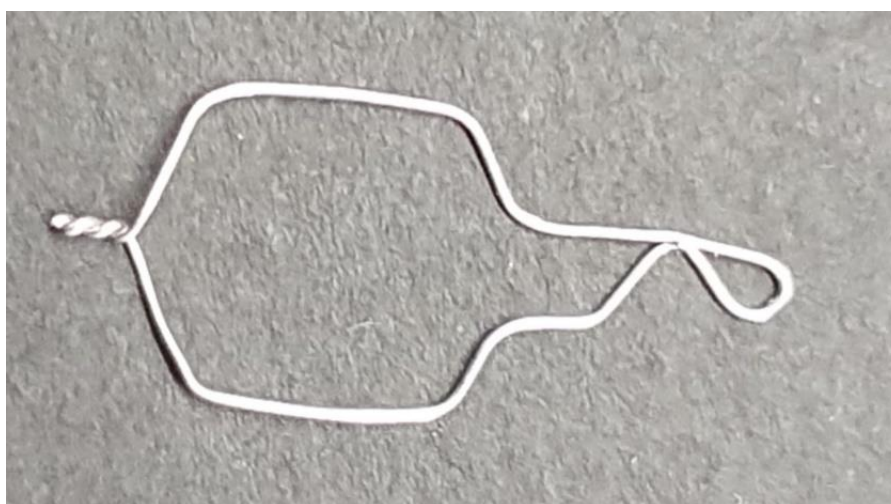
Use the softer and flexible ELs at the initial banding visit as these are easier to place and less likely to result in bracket debonds. Lighter pastel shades tend

to absorb food stain and discolour easily while deeper colours retain their pigment.

Patients are often undecided about which colour ligatures to choose, and their uncertainty can eat into practice time. This delay may be overcome by allowing patients to select the colour of their ELs from a colour chart, while sitting in the waiting room.

Steel ligature may be pre-formed as purchased from the supplier or they can be fabricated in house on a jig from a spool of 0.010" SS wire. To avoid confusion when tying SLs and standardise the procedure, the ends of a SL are wound in a clockwise direction when fixing the AW to the bracket and anticlockwise when releasing the AW from the bracket.

A Kobiyashi hook is a SL with a little loop incorporated into it so that when tied to a bracket can serve as a hook on the bracket for the attachment of elastics or springs.



*Figure 71: A Kobiyashi hook*

## **Ligation Process**

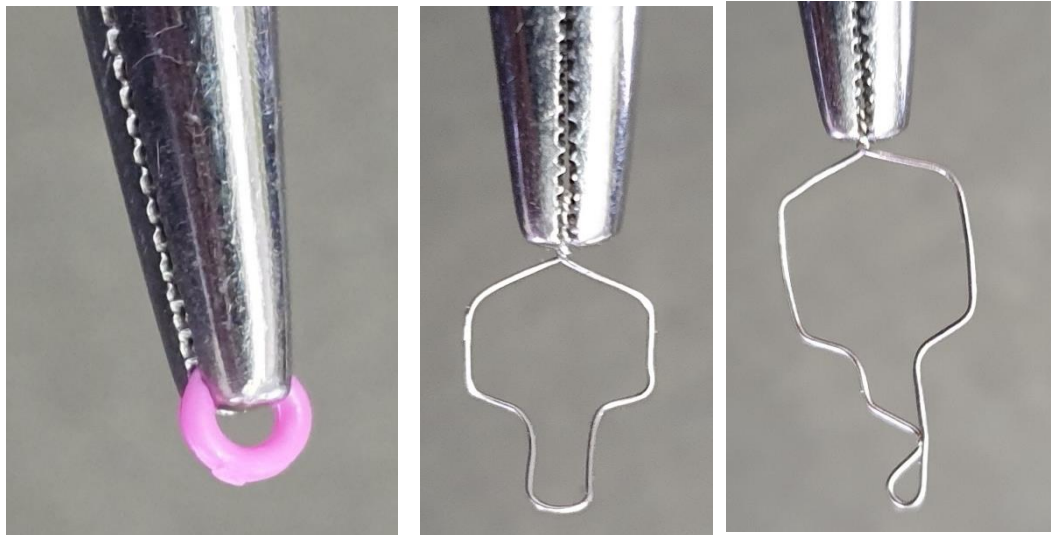
Ligatures are attached to the bracket with a self-releasing Matheiu needle holder. When loading the Matheiu needle holder with an EL, the assistant should grasp only the outer perimeter of the EL with the beak tips of the Mathieu needle holder leaving the central opening of the EL patent. The assistant then finds the raised and empty working hand of the operator and plugs the loaded Matheiu needle holder into it.

Thin and narrow tipped Matheiu needle holders are preferred over Matheiu needle holders with broad and thick tips as the latter can obstruct the openings of the ELs and complicate the engagement of the EL to the bracket tie wings.



*Figure 72: Broad and narrow tipped Mathieu needle holders*

*Figure 73: Mathieu needle holders loaded with an EL, SL and a Kobiyashi hook*



After the AW has been positioned into the bracket slot the central opening of the EL is then slipped over the one tie wing of the bracket, usually the disto-occlusal wing for the left quadrants of the mouth and the mesio-occlusal wing for the right quadrants. Without pulling the ligature away from the tooth, the EL is then gently stretched parallel to the buccal surface of the tooth and carefully rolled over the opposing wing in the vertical plane (i.e. a gingival wing). Thereafter, it is stretched horizontally and parallel to the tooth to engage the other gingival wing and lastly it is stretched vertically again to engage the remaining occlusal wing. Once all four tie wings are engaged, the handles of the Matheiu is then compressed and unclipped to release the EL. A sharp probe may be used to roll the EL over a tie wing that has been missed or come undone.

It is time saving to use two Matheiu needle holders for the ligation process. While the operator ties the wire to the bracket using the one Matheiu, the assistant can load an EL on the other. Also, use self-releasing Matheiu needle holders. The ligation procedure should have a surgical theatre simulation to it where the operator opens his/her hand and the assistant loads it with the appropriate instrument.



*Figure 74: Exchange of loaded and unloaded Mathieu needle holders*



*Figure 75: Using a dental probe to slide an EL over a tie wing*

In order to re-centre the crown face of a rotated tooth, the bracket would need to be placed slightly mesially in a mesially rotated tooth and distally in a distally rotated tooth. On rotated teeth, it is advisable that, at the initial visit, to tie only the wings that are closer to the direction of rotation i.e. for a mesially rotated tooth, tie only the mesial wings of the bracket and for a distally rotated tooth, tie only the distal wings. After one or two visits, some derotation would have

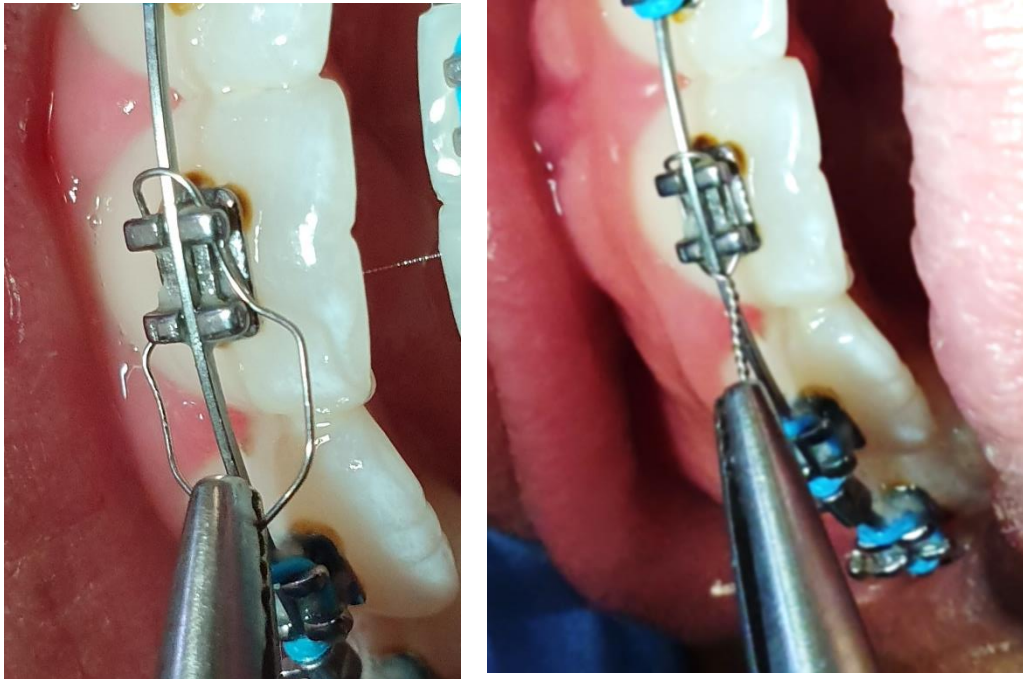
occurred and all four wings can be engaged. To obtain a perfectly central position on the crown face, it may be necessary to reposition the bracket on the derotated tooth's corrected position.

In situations where it is essential that the ligature should not become undone, SLs should be used instead of ELs. This is usually prepared on:

1. Rotated teeth
2. Severely displaced teeth
3. Teeth bordering a coil spring
4. Ensuring full engagement of the final AWs to maximise expression of torque
5. In patients who have a long absence between appointments
6. To connect adjacent teeth for anchorage

Long SLs can be laced around adjacent brackets in a figure 8 configuration to set it up as an anchor unit or stabilise the arch.

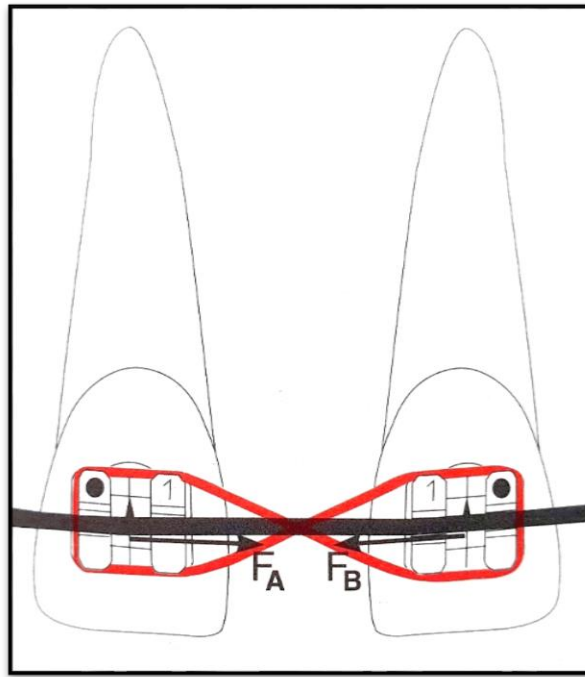
In placing a SL on a bracket, the loop of the SL hugs over the AW and the two limbs of the SL slide underneath the bracket tie wings. The ends of the SL are then brought together and twisted over the AW. In this way the AW is secured into the bracket slot by having the SL over the AW mesial and distal to the tie wings. The two ends of the SL are always wound together under some tension in a clockwise direction until the twisted wire starts to wind on itself. The tied end of the SL is then cut leaving a 3mm tail that is neatly tucked away beneath the AW with a ligature tucker so as to prevent any irritation or injury to the patient's lips or cheeks.



*Figure 76: Engagement of an AW with a SL*

Ligation of the SL must be done slowly as the procedure can be painful and uncomfortable to the patient. Winding of the SL should stop when the ligated tail turns on itself. Failing to stop may result in a bracket debond or breakage of the SL.

Elastomeric chain or power chain (PC) consist of ELs connected to one another by a link. It is dispensed in a spool and available in different colours and used to join several adjacent teeth with some force between them. The PC may be long linked for less force or short linked for more force and its application can be varied such as ligating several teeth together to close spaces between them or retracting a canine by applying it from the hook on the molar tube to the hook on the canine to the exclusion of the premolars.



*Figure 77: PC on Anterior teeth to close spaces*



*Figure 78: Long and short linked PC*

Another accessory that can be attached to a bracket is elastic thread or elastic string. Elastic string is tied around the bracket, stretched and tied to the AW to move the tooth in the direction of its knot on the AW.

Elastics, whether ELs, PC, elastic string or interarch, have a limited shelf life, become stale and break easily. Always use fresh elastics and do not overstock on elastic inventory.

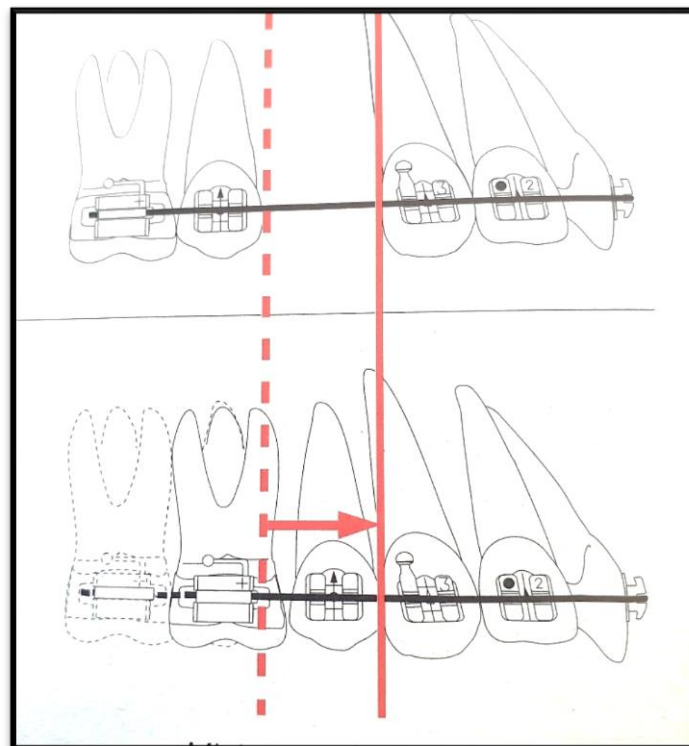
## Chapter 6

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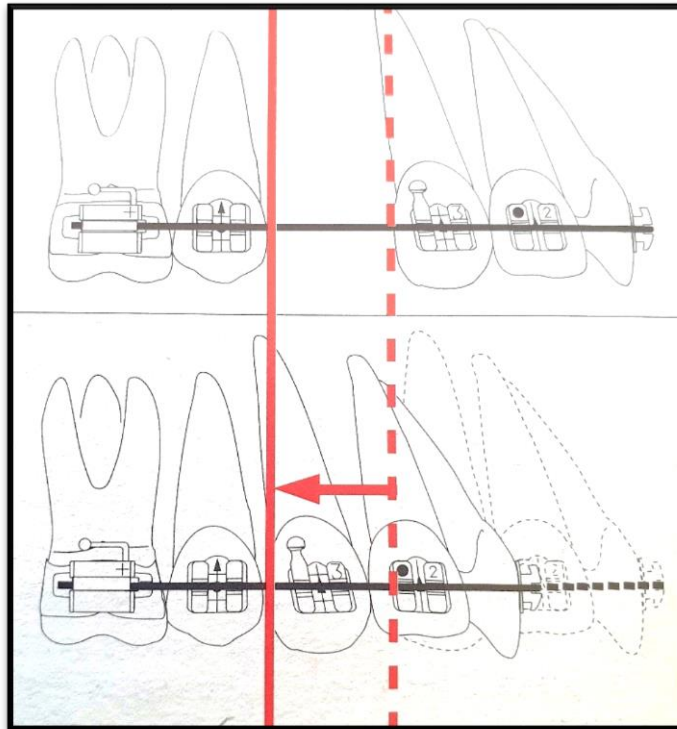
### Anchorage

Before applying any force to move a tooth to its planned position, consideration should be given to the reactive force as per Newton's third law. Neglecting to consider these forces can impact negatively on the final result.

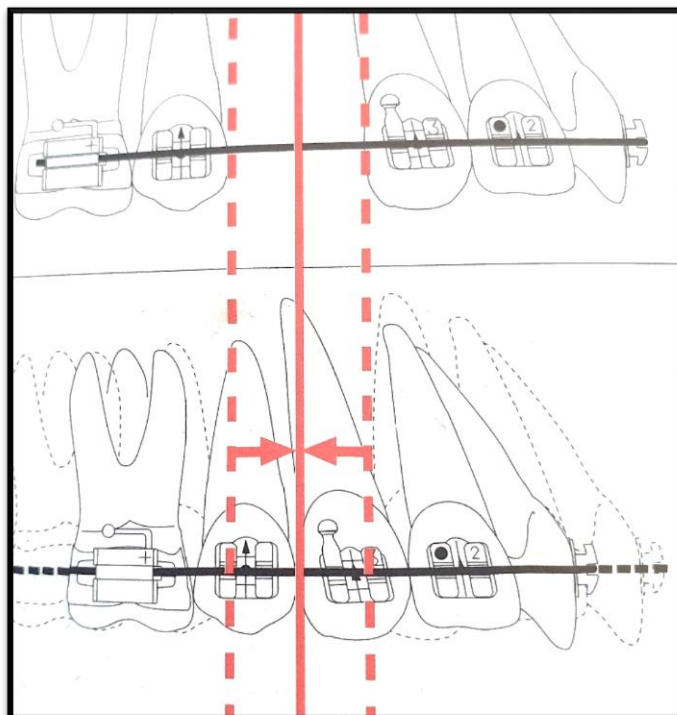
The point from which the effective force is generated is referred to as the anchor. It is therefore understandable that if the anchor is not appropriately planned and secure, the reactionary force will cause the anchor to move. The anchorage requirement will depend on amount of force that is needed to move a tooth or a segment of teeth. The anchor value should therefore always be greater than the effective force. If it is less, anchorage will be lost and effective tooth movement will not take place. Anchorage may be classified as minimum, maximum or reciprocal.



*Figure 79: Minimum anchorage*



*Figure 80: Maximum anchorage*



*Figure 81: Reciprocal anchorage*

It is most unfortunate and detrimental to patient care if space that has been created whether by extraction, expansion or enamel reduction, is lost due to poor planning, preparation and maintenance of the anchor unit.

It is always judicious to err on the side of more anchorage than less.

Anchorage can be prepared in different ways. Intra-orally one may use TPAs, a Nance appliance, LAs, stops in the AW, lacebacks or figure 8 ligatures and bone plates or temporary anchorage devices (TADS). Individually or in combination these anchors can provide a stable source from which an effective force can be generated.



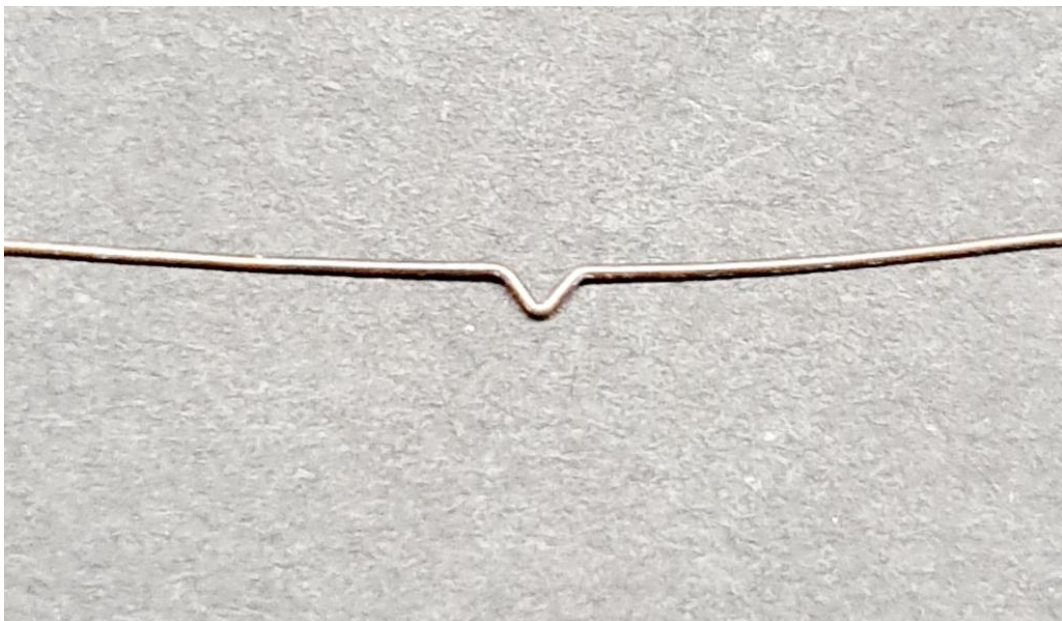
*Figure 82: Transpalatal arch*



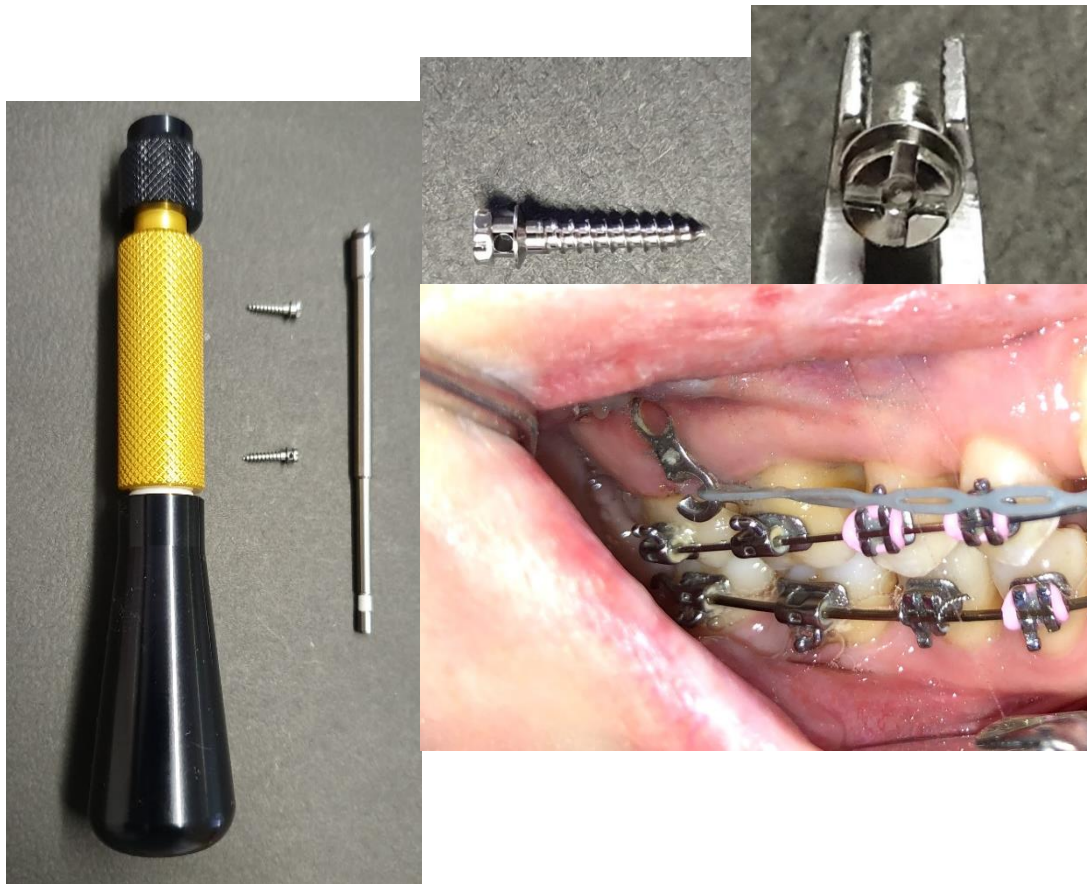
*Figure 83: A Nance appliance*



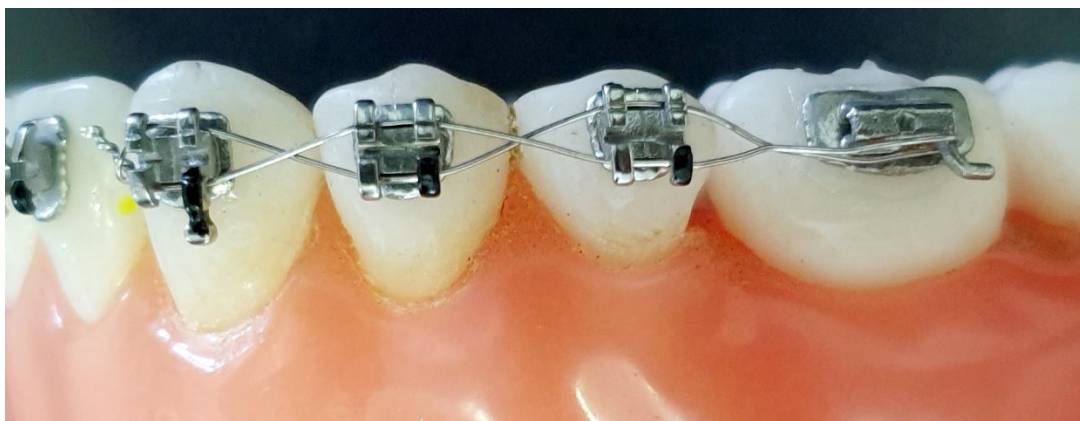
*Figure 84: LA*



*Figure 85: Stop in the AW made with a stop forming plier*



*Figure 86: Temporary anchorage devices (TADS) and bone plates for anchorage*



*Figure 87: Anchorage by lacebacks or figure 8 ligatures*

Occasions may arise whereby teeth or segments thereof need to be moved toward one another to close space or against one another to open space. In such instances the anchorage is referred to as reciprocal because the anchor unit will need to move an amount equivalent to the teeth to which the effective force is applied. Closing loops, open and closed coil springs can be used in such instances where reciprocal anchorage is required.



*Figure 88: An open coil spring to separate teeth to make space*



*Figure 89: A close coil spring to close space*



*Figure 90: An activated boot loop to close space between adjacent teeth*

## Chapter 7

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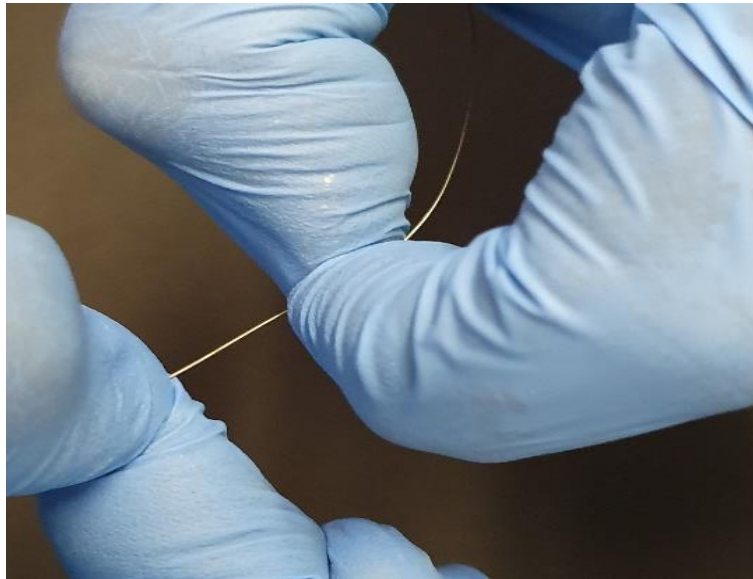
### Wire Modifications

Teeth move most efficiently along a straight line as the frictional resistance between bracket slot and wire is minimized. It is therefore essential that the bracket slots of all the teeth in an arch are coordinated on the same horizontal plane after the alignment phase. During this phase all wires should be tested on a flat surface before placement to ensure that there are no unwanted bends or kinks in the wire that would cause undue friction and binding which would hinder tooth movement.



*Figure 91: Confirming wire flatness to ensure levelling of the dental arches*

The management of NiTi wires are different from that of stainless steel (SS). NiTi is a memory wire that resists permanent deformation and reverts to its original shape. It is therefore the ideal wire to use in the initial alignment of teeth to get the bracket slots on the same horizontal plane which allow for ease of tooth movement during the intermediate phase. There are occasions when one may need to alter the arch shape of the NiTi wire, as in increasing or decreasing arch size or by the addition of reverse curves. This may be done by pinching the wire between thumb and index finger or between the beaks of an arch forming plier (also known as a canine offset plier or a De la Rosa plier) and sweeping it along the wire.



*Figure 92: Altering the shape of a NiTi wire*

## **Wire Properties**

In orthodontics, wires of various alloys with various cross-sectional shapes and dimensions are used.

### **Nickel-titanium wire (NiTi)**

Primarily consisting of nickel, titanium and optionally of third elements such as cobalt or copper. (The name nitinol is an acronym derived from nickel and titanium composition, along with the suffix –nol which stands for Naval Ordnance Laboratory.)

The original nitinol wire possessed two features of considerable importance for clinical orthodontics:

- A very low elastic modulus (E), corresponding to about one-fifth of the force delivery of SS wires.
- An extremely wide working range.

A “second generation” superelastic Chinese nickel-titanium alloy exhibits loading and unloading characteristics more pronounced than those of the original nitinol wire.

A “third generation” Japanese nickel-titanium alloy also exhibits super elastic behaviour.

The super elastic behaviour and shape memory characteristics of nickel-titanium alloys are based on a reversible transformation between the austenitic and martensitic NiTi phases.

Some of the available nickel-titanium wires are termed thermally activated wires due to the fact that their transition temperature is close to the level of body temperature.

NiTi wires cannot be soldered or welded without losing their properties, and their friction coefficient is higher than that of SS.

### **Stainless steel wire**

SS is an alloy composed of iron and carbon that contains chromium, nickel, and other elements that impart the property of resisting corrosion. The wire is amenable to welding and soldering. It softens by heat which increases its elasticity and manipulation, minimizing breakage. Resilience and alterations in the wire are retained when the wire returns to room temperature.

### **Australian wire**

A round austenitic SS wire. There are various grades of Australian wire, but the Begg treatment technique mainly uses the 0.016-inch (0.41-mm), so-called "Special Plus" wire which is a versatile wire suitable for any technique. Another characteristic of the wire is its brittleness. It is recommended that when bending Australian wire, the flat rather than the round beak of the pliers be used and that the bend be placed very slowly, to avoid breakage. Following bending, the AW can be heat-treated, which makes it harder and more resistant to permanent deformation.

### **Braided wire**

Also referred to as Multistrand wire, Braided or Co-axial wire. This wire has high flexibility. Multistrand AWs can be round or rectangular and can be used for initial alignment instead of NiTi.

### **Rectangular wire**

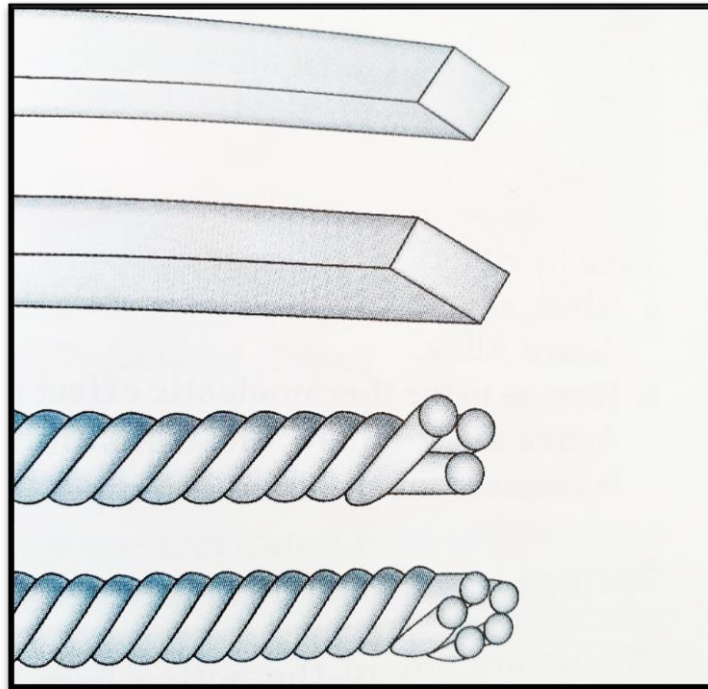
An orthodontic wire with rectangular cross-section.

### **Round wire**

An orthodontic wire with round cross-section.

### **Square wire**

An orthodontic wire with square cross-section



*Figure 93: Wire design*

### **Load/deflection (Force) rate of a wire**

This is a mechanical characteristic of orthodontic springs or wires, describing the dependence of the magnitude of the generated force on the amount of deflection (deformation, activation). It expresses force per unit displacement of the spring; and is measured in cN/mm or g/mm).

The five major parameters available to the clinician for varying the load/deflection rate are:

1. Wire cross-section: The load/deflection rate varies directly with the fourth power of the diameter of a round wire and with the third power of the width (large dimension) of a rectangular wire. Therefore, reducing the cross-section of wire can reduce the load/deflection characteristics of an orthodontic appliance.
2. Wire length: The load/deflection rate varies inversely with the third power of the length of a wire segment (or cantilever); thus small increases in wire length can reduce the load/deflection rate dramatically.
3. Wire material: The load/deflection rate is proportional to the modulus of elasticity (E) of the material. A low E will deliver less force for an equal deflection; than a wire with a high E.
4. Wire configuration: Bending loops of various shapes into an AW reduces its load/deflection rate by increasing the wire length.

5. Constraint conditions: The load/deflection rate of a wire segment depends on its mode of ligation between two teeth. A wire segment tightly ligated in two edgewise brackets delivers a much higher load.

In addition to their inherent frictional resistance, Niti wires with diameters of 0,016 inches or less are not favourable for sliding teeth along the AW as one would do to close spaces, because the NiTi wire will buckle under the force, potentiating the friction, which will strain the anchorage and limit tooth movement.



*Figure 94: Deformation of 0,016 SS wire and 0.016 NiTi wire by the same force*

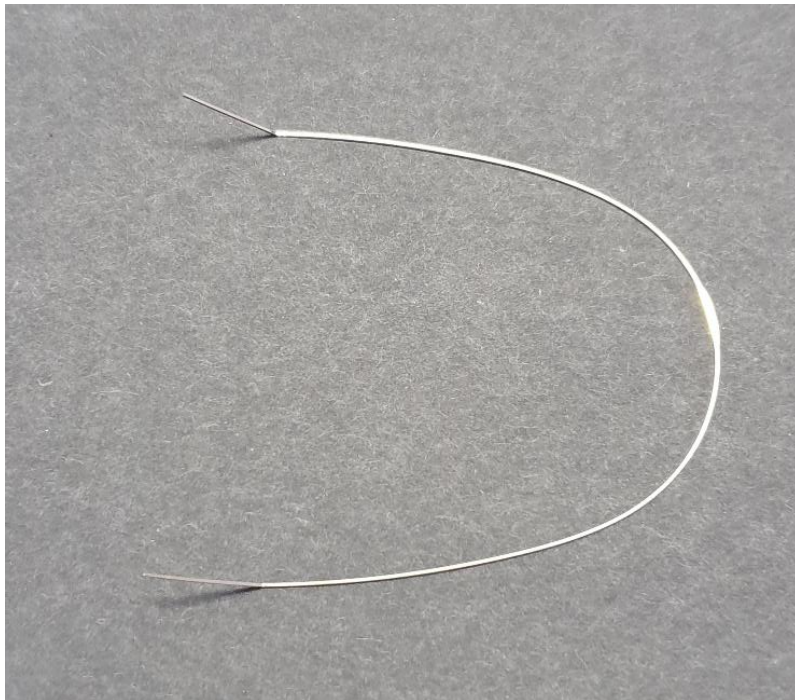
### **Sliding and closing loop mechanics**

Using SS wires, tooth movement along an AW can be executed either by sliding mechanics or closing loop mechanics. Sliding mechanics entail the movement of teeth (usually one at a time) along the AW using elastics or springs while closing loop mechanics involves the additions of bends in the AW to effect the movement of groups of teeth.

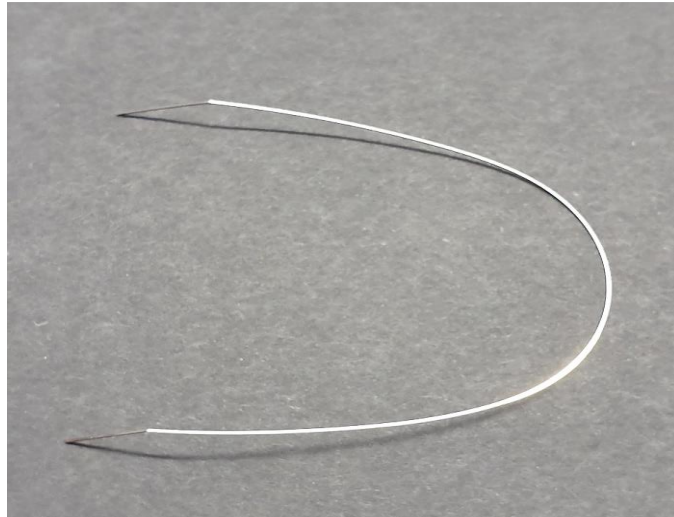
## Wire adaptations

### Tip back bends

These are placed at the distal ends of SS AWs before they are loaded into the buccal tubes of the first molars. These bends may be either tipped down or tipped up and once ligated, the effect of the mesial segment of the AW would be to intrude or extrude the engaged teeth. The distal segment having the tip bend will have the opposite effect on the molars.



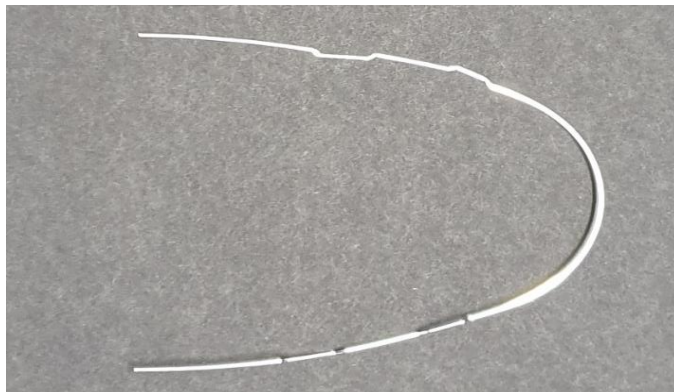
*Figure 95: Tip back bends (up)*



*Figure 96: Tip back bends (down)*

### **Offset bends**

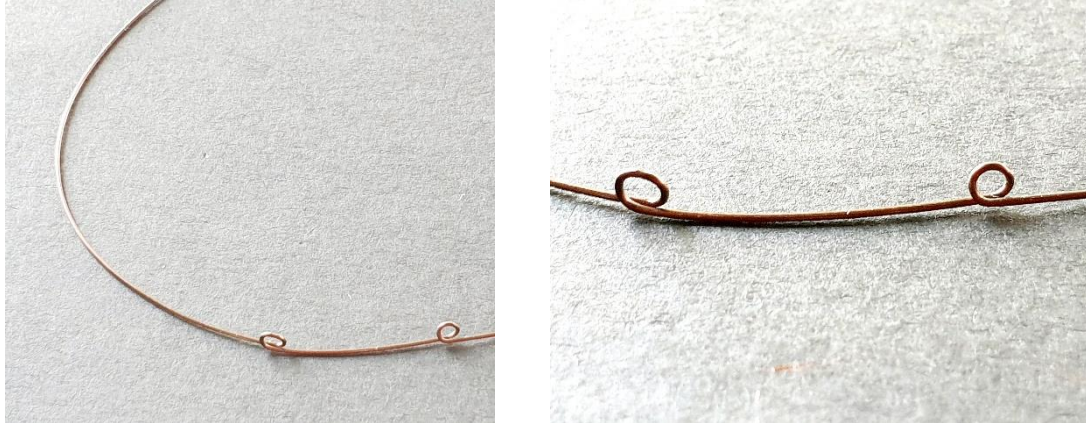
These can be added to SS AW to reposition a tooth or group of teeth lingually, buccally, occlusally or gingivally.



*Figure 97: Horizontal and vertical offset bends*

## Circular stops

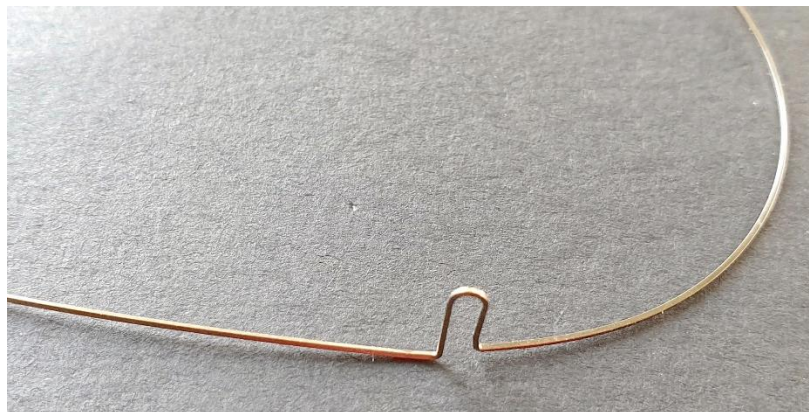
These are circular bends placed in a SS AW to limit the horizontal movement of teeth. They may also serve as latch points for elastics or springs.



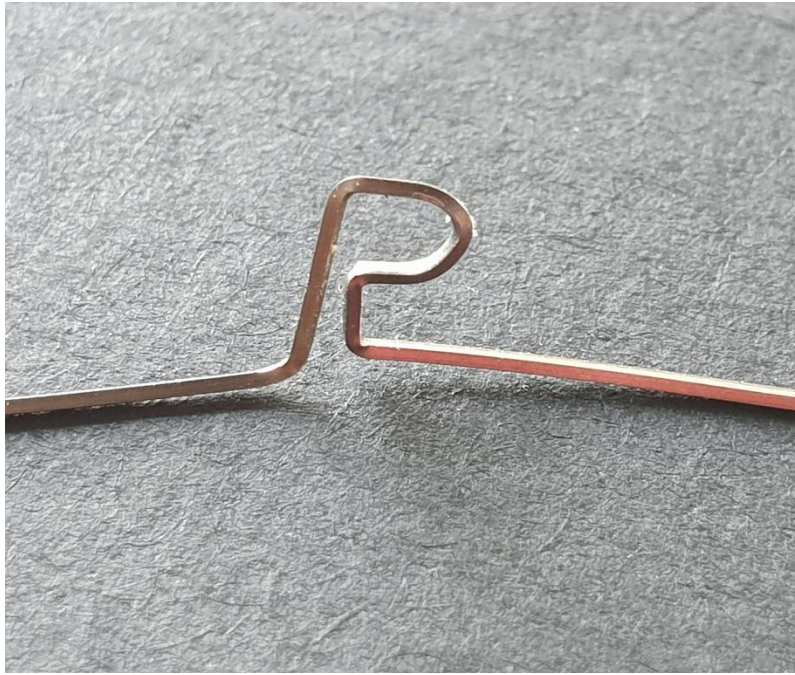
*Figure 98: Circles or circular stops*

## Loops

Different types of loops may be added to SS AW. They add length to the wire, making it more flexible and can also serve as latch points for accessory attachments. They may also be activated to generate forces called closing loop mechanics. This is achieved by stretching the distal end of the AW that projects from the buccal tube on the molar and cinching it. In trying to regain its shape the activated loop will cause teeth to move toward the loop.



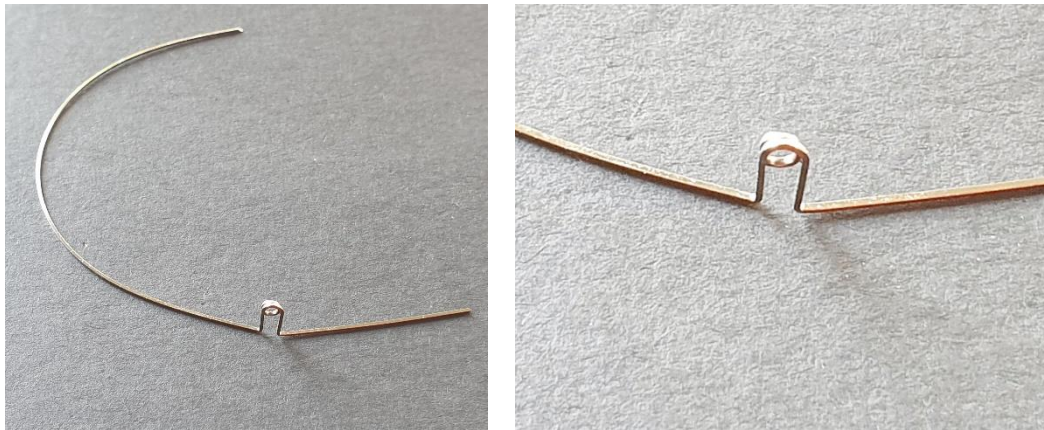
*Figure 99: Vertical loop*



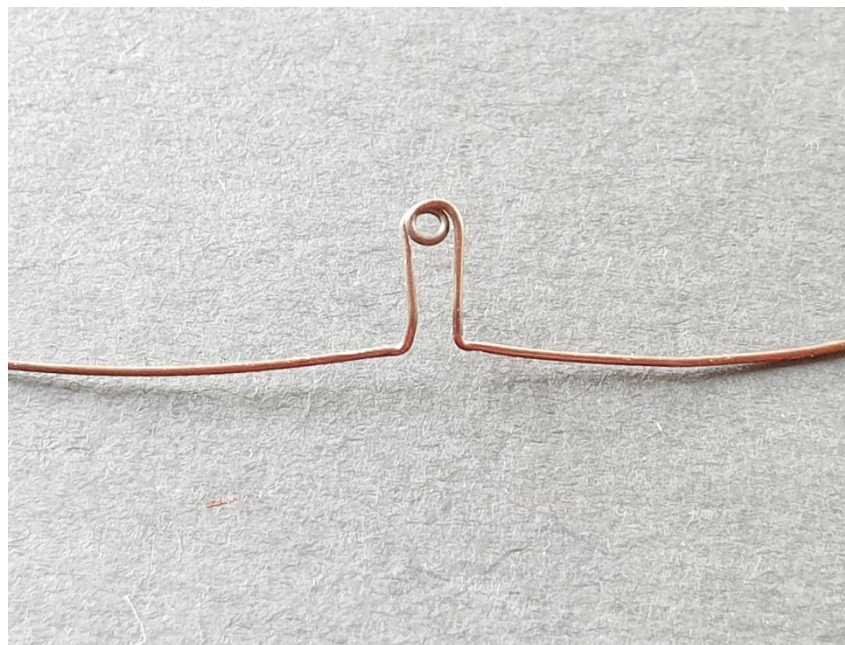
*Figure 100: Boot loop*



*Figure 101: T loop*



*Figure 102: Helical loop*



*Figure 103: Ballista loop*

Wire modifications can be incorporated into an 0,016" round SS wire up to a 0,016X0,022" SS wire with ease, but are more difficult to fabricate in thicker wires. Forces that are incorporated into the bends are also not easily expressed and dissipated in thicker wires.

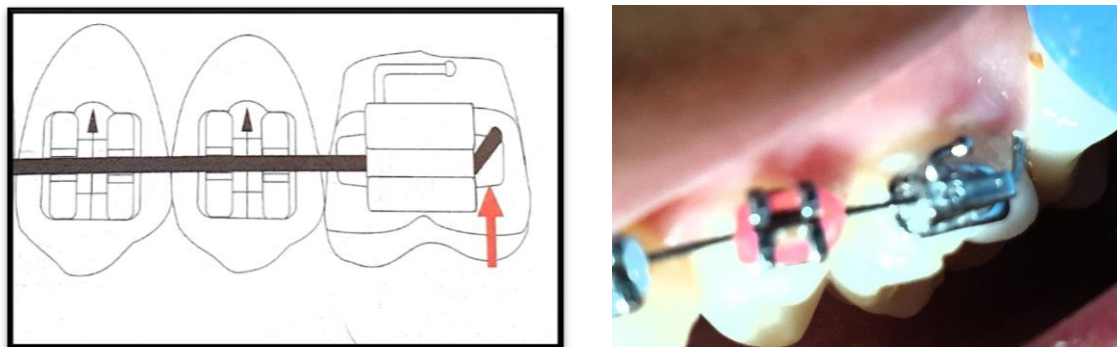
Arch form is specific for each patient and it is prudent to maintain the patient's original arch shape through all wire changes.

Initial and intermediate wires are fairly flexible and can be engaged into the bracket slot with relative ease. Care should however be exercised when forcing wires into the bracket slot as it may cause bracket debonds. If unattainable, it would be safer to step down to a thinner and more flexible wire for a period to enable bracket alignment before proceeding with thicker wires.

Final wires are used to detail the occlusion and to express third order bends (torque). Torque is a buccolingual movement of teeth. When crowns are torqued buccally, the reciprocal force would cause the roots to move lingually. It is empirical that when the crowns of teeth are torqued buccally, spaces will appear between them. To avoid the crowns from moving and allow the roots to torque it is essential to cinch the wire distal to the last tooth. This will confine the AW to a fixed length and will prevent the crowns from flaring outward. The roots would move lingually or palatally into the alveolar bone and the crowns would not be able to flare out labially or buccally.

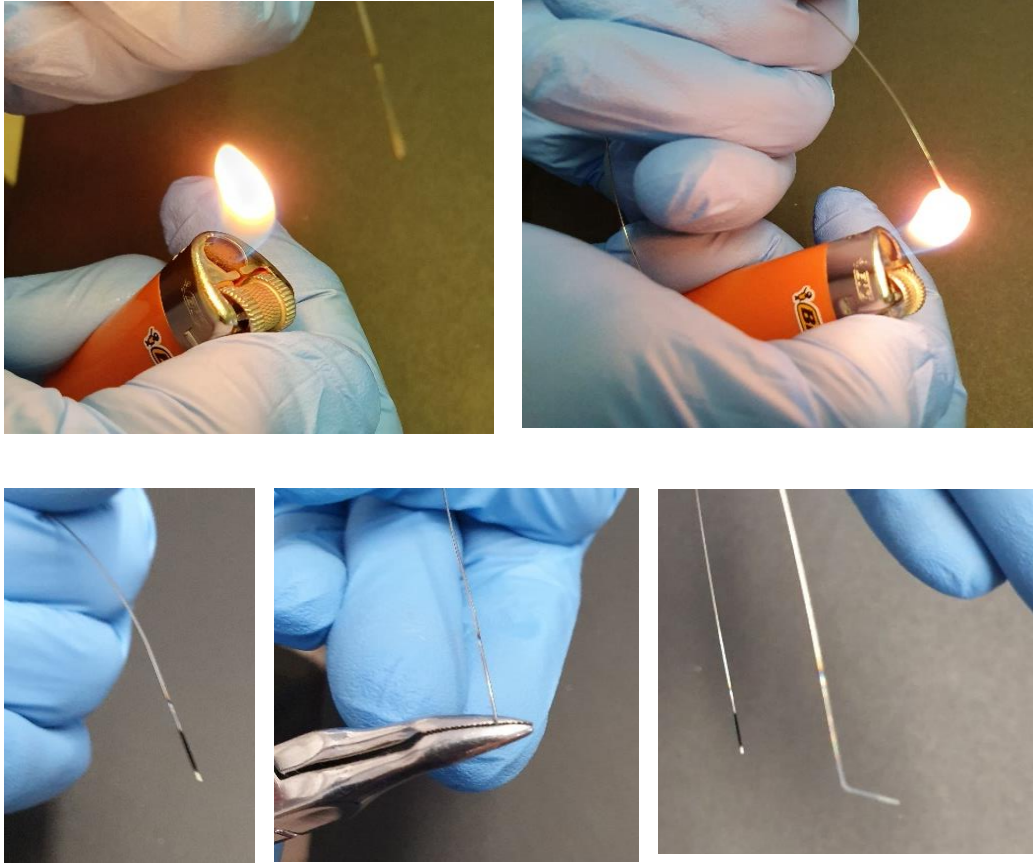
Cinching is a process whereby the ends of a wire that project beyond the buccal tubes of the last teeth in the arch are bent to lock the wire into position and prevent the wire from sliding mesially along the arch and out of the buccal tube.

Cinching is done intra-orally after the wire has been tied into all the bracket slots. It can be done with ease on SS wire using a Weingart plier. Because of the inherent memory of the NiTi wire, it cannot be easily cinched. The property of the wire must first be changed and this is done by heating only



*Figure 104: Cinching of a SS wire distal to the molar*

the tips of the wire red hot with an open flame (a cigarette lighter can be useful for this purpose) and cooling it. The cooled wire is then gently inserted into the buccal tubes and cinched.



*Figure 105: Cinching a NiTi AW*

## Chapter 8

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### Clinical application of wire modifications

As mentioned earlier, always **treat with the end in mind**. Bends and modifications to the AW are intended to move teeth to planned destinations. However, for every action there is always an equal and opposite reaction (Newton's third law). Therefore, one must be vigilant of the reactionary forces precipitated by AW modifications.

Modifications can be placed in SS wires of up to 0.016X0.022" with relative ease. A TMA (Beta-titanium wire) is a highly resilient wire that allows intricate bends with ease. It is dispensed in a variety of sizes and is more costly than SS wire. However, it is a very malleable and elastic wire that once bent, retains its shape.

When incorporating bends into an AW, the exact position of the intended bends are first marked intra-orally on the AW with an appropriate marker. The bends are then forged into the wire extra-orally. While there are pliers intended for specific bends, the bird beak plier is a very versatile instrument that can be used in effecting most bends.

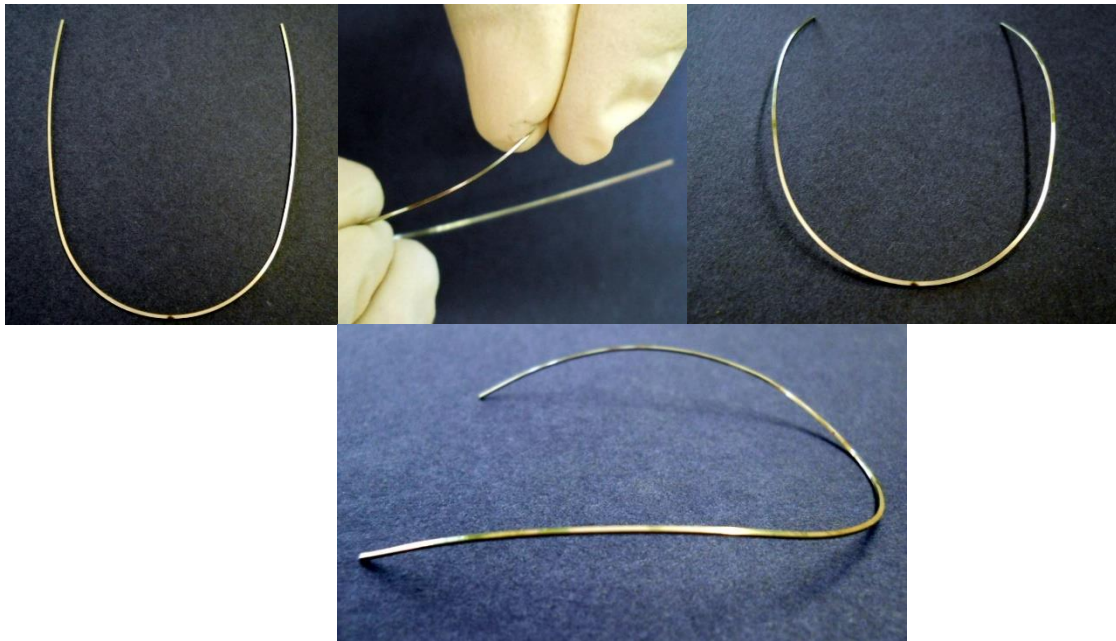
NiTi wires are strong memory wires and are not amenable to shape modifications. Heating the wire with a gas burner or cigarette lighter until it is red hot alters the wire properties and allows for easy manipulation of the wire. After heating it, the wire becomes inelastic and loses its memory shape. Such an alteration of the properties of NiTi is only useful when applied to the distal tips of a NiTi AW so as to cinch the wire behind the molar tubes, but is ineffective in adding active loops or bends in the wire to effect tooth movement.

Sweeping the NiTi wire between thumb and index finger however; will generate sufficient heat to initiate shape changes without loss of elasticity and memory. This technique may be useful in expanding or constricting arches or adding reverse curves to the AW.

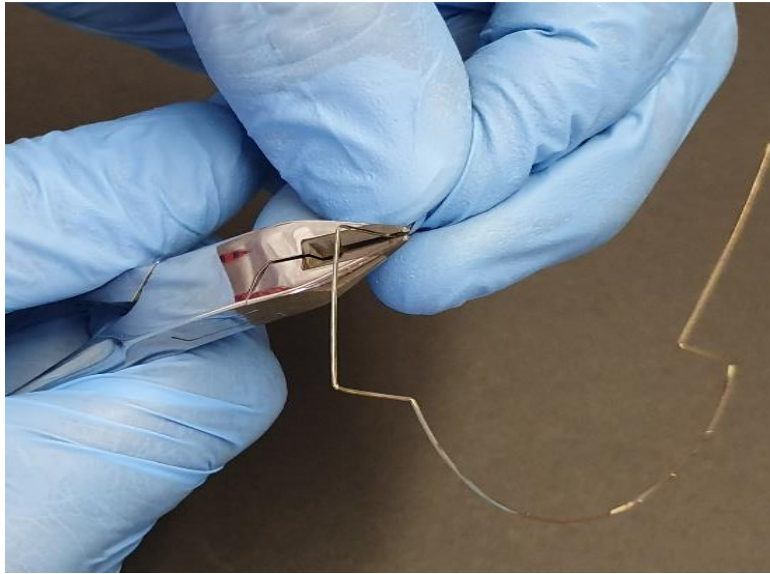
Widening or narrowing of the AWs are some of the most frequent modifications that one would make to an AW, particularly if the office inventory contains only lower AWs. Modifications are effected using an arch forming plier to either open or close the arch. **Always be sure to respect and maintain the specificity of the patient's arch size and shape.**

**Reverse curves** can also be swept into a wire using finger pressure. After incorporation of these, the wire must be checked for perfect tripod balance by placing it on a flat surface i.e. the anterior centre of the wire and the two posterior ends must form 3-point contact on a flat surface with the left and right curves of equal height and superimposing one another when viewed from the side.

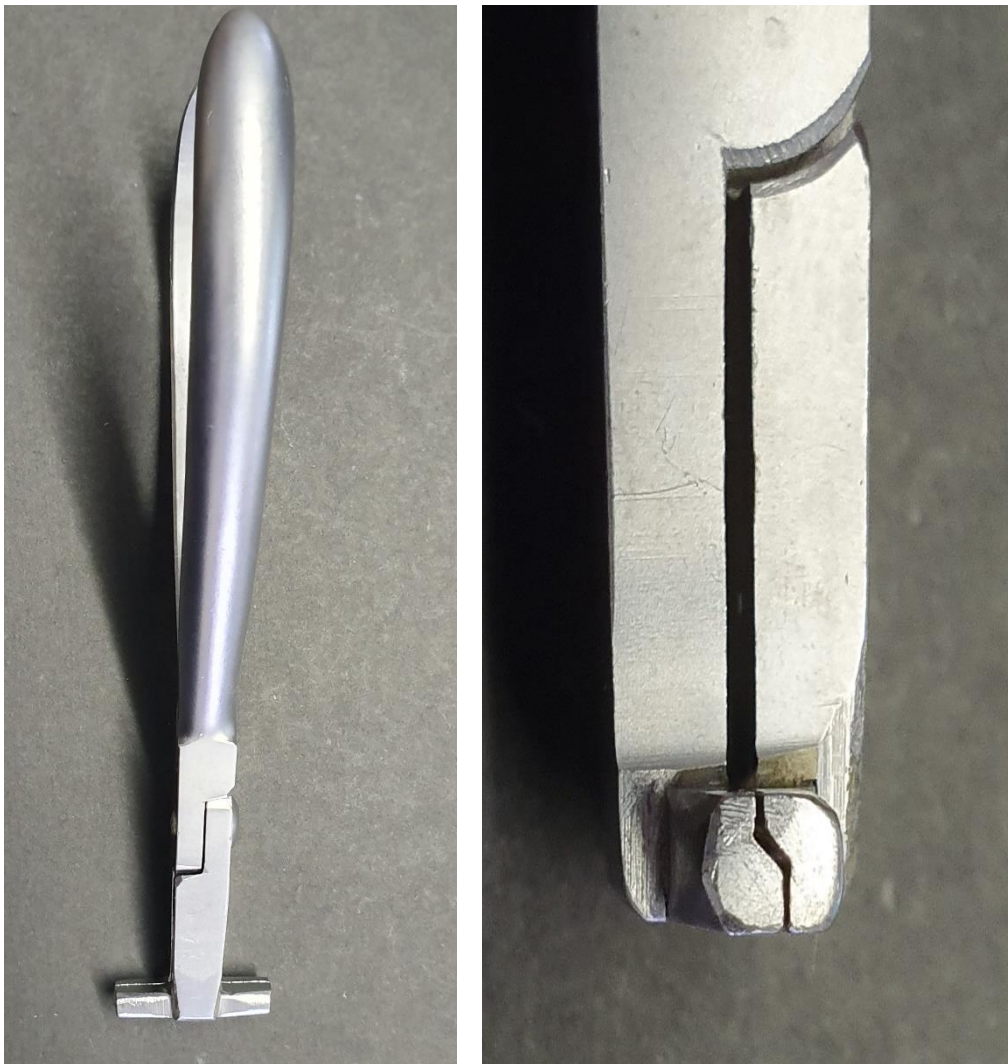
*Figure 106: Finger moulding a reverse curve into an AW*



**Offset bends** (up, down, in or out) are useful to align individual teeth and can readily be effected using a bird beak plier. As with all forces placed on any tooth, the reactionary force on the surrounding teeth should be considered and accounted for. The tip bends should be mild and progressive so as to allow for bracket engagement of the wire and not cause excessive force or bracket debond.



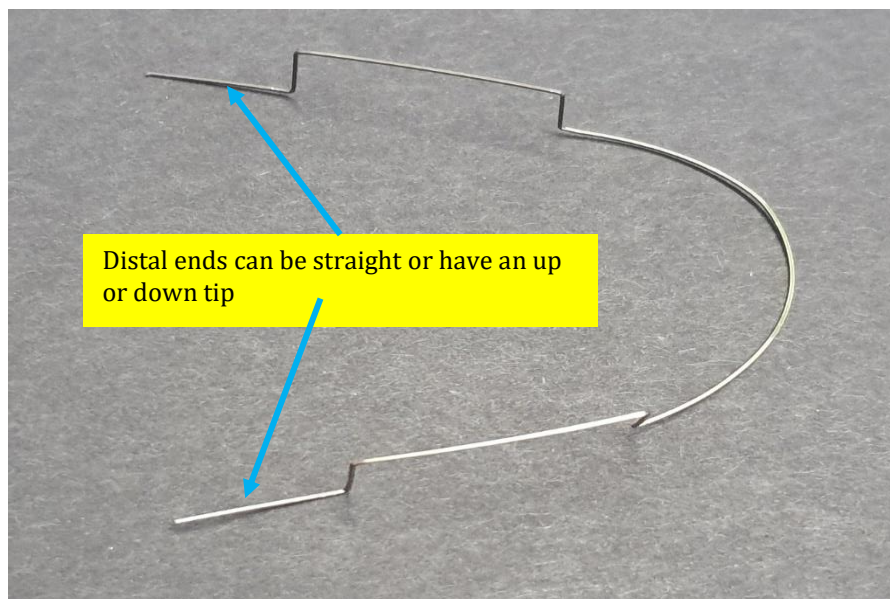
*Figure 107: Bird beak plier is a useful plier for effecting most AW bends*



*Figure 108: Double-sided step plier to insert offset bends in the AW*

**A tip back bend** is a 20 to 45 degree bend placed in the wire just in front of the molar tubes that can also be effected by a bird beak plier. Depending on how it engages the molar tube, the tip back bend in an AW can be applied to either intrude or extrude the incisors and as a consequence could assist in opening or closing the bite. The reactionary force on the molar should be considered as a tip back bend will mesialise or distalise the involved molar crown. To maximise the effect of a tip bend on the anterior teeth the arch wire can be bent in such a manner so as to bypass the premolar teeth.

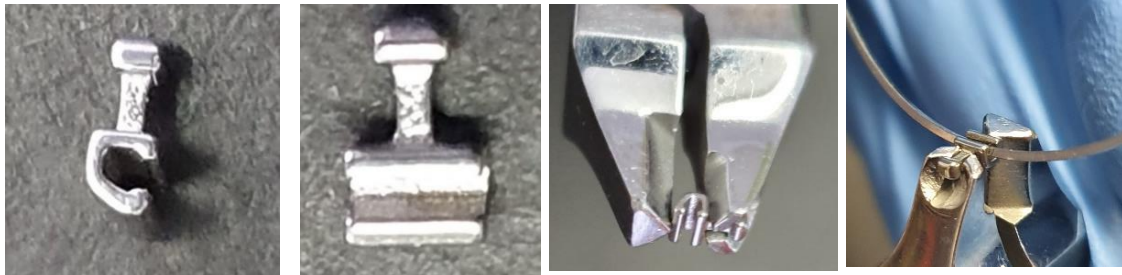
**A utility arch** is a very versatile and useful modification to the AW. The utility arch essentially consist of a vertical bend in the arch in front of the molars, a horizontal bend to bypass the premolars and canines and a downward bend so that the anterior perimeter of the AW can engage the incisor teeth. Depending on the treatment objective, the canines can be excluded from the bypass. The utility arch can be used to align, intrude, extrude, procline and retro-cline anterior teeth in both the mixed and permanent stages of tooth development. Modifications such as tip back bends and loops may be added to the utility arch. Helical loops may be added to mesial vertical limbs of the utility to either protract or retract the anterior teeth. For protraction the distal ends of the utility must be cinched behind the molar to anchor it and prevent the wire from slipping forward out of the tubes and for retraction of the anterior teeth the distal vertical limbs of the utility will press against the molars and offer adequate resistance to procline the anterior dental segment.



*Figure 109: A utility arch can incorporate a tip up or down bends on the molar tube*

**A circular stop** can be bent into an AW using a stop forming plier. These may be bent anywhere along the AW but are commonly inserted between the lateral incisors to prevent them from flaring; or in front of the molar tubes to maintain arch dimension, avoid mesial movement of the molars, and prevent the wire from sliding backward and extruding beyond the last molar tube.

Crimpable stops or crimpable hooks may be added intraorally to square AWs of 0,016X0,022" and larger diameter, using a hook crimping plier. A crimpable hook can serve as a stop or as an attachment for intraoral elastics or springs.



*Figure 110: Placing a crimpable hook on an AW*

Vertical loops with or without helices, boot and T loops are other modifications that can be bent into the AW. They serve as attachment points and can be activated to initiate closing loop mechanics i.e. once attached to all the brackets, the loops are activated by stretching the wire distal to the last molar teeth on either side of the arch and cinching it. As the stretched loop tries to close and regain its shape it drags the teeth together and closes the spaces between them.

Multiple loops can be incorporated into segments of wire to form helices. These can be used in sectional mechanics to open or close spaces. For the latter, it is crucial that the ends of the wire be cinched

A bihelical spring can be used with the initial NiTi AW to create space for the initial alignment of teeth.

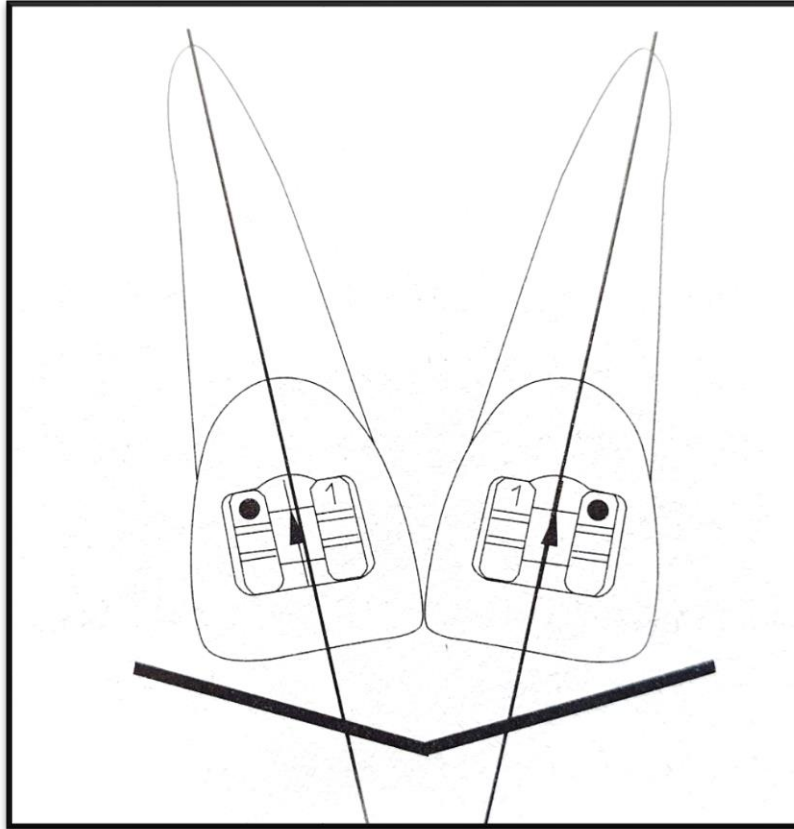


*Figure 111: A bihelical spring made of 0.014" SS*

A ballista loop has a catapult effect and is useful for the eruption of impacted teeth, especially canines. It is a helical loop that is positioned horizontally on the AW to erupt either palatal or buccally impacted teeth. An eruption chain that is attached to a bracket on the unerupted tooth is ligated with a SL to the helix of the activated ballista loop. Activity of the ballista loop is manifested by a change from its horizontal position toward the unerupted tooth with a force of approximately two ounces.

*Figure 112: A modified ballista loop with an attachment to erupt a tooth*





*Figure 113: A gable bend to upright crowns and tip roots to one another*



*Figure 114: An eruption chain to engage an impacted tooth*

A force measuring instrument in the orthodontic armamentarium is useful to measure the orthodontic forces applied to teeth. Orthodontic forces to move teeth should always be kept at a minimum and an Odontrix can be of assistance in this regard.

## Orthodontic Force

For effective movement of an object, a force should ideally be applied through the centre of resistance (COR) of the object. Because a tooth is embedded in a biological environment, this is unattainable except in certain types of movement. Any force that is not directed through the COR will cause the tooth to rotate about its COR.

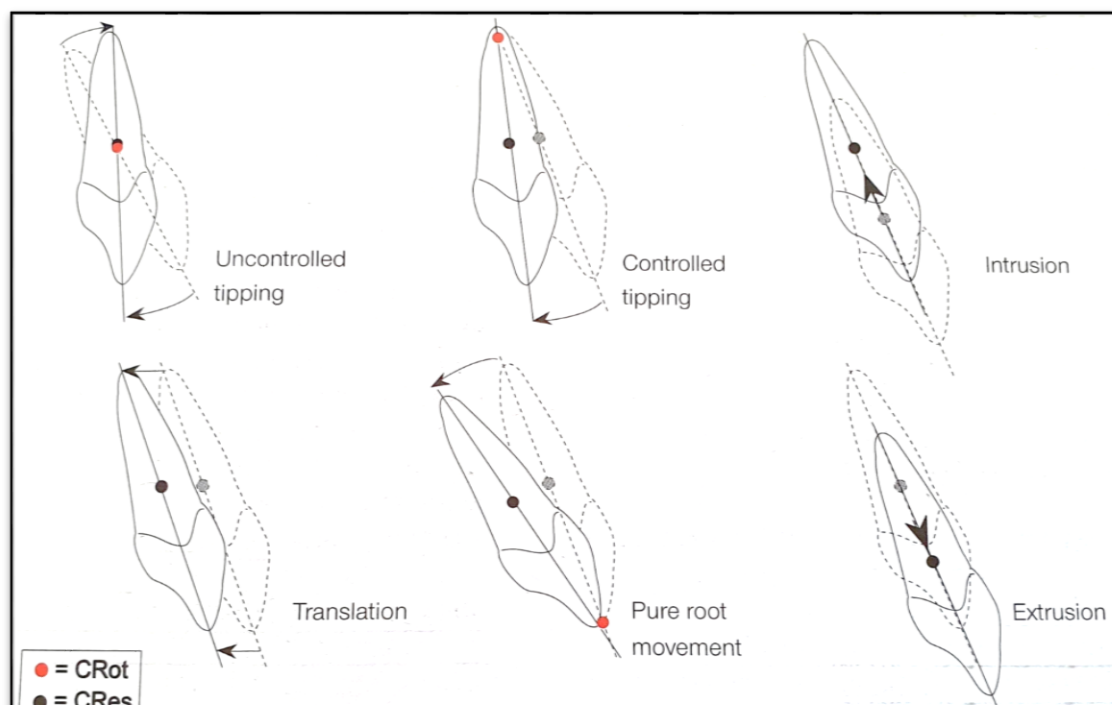
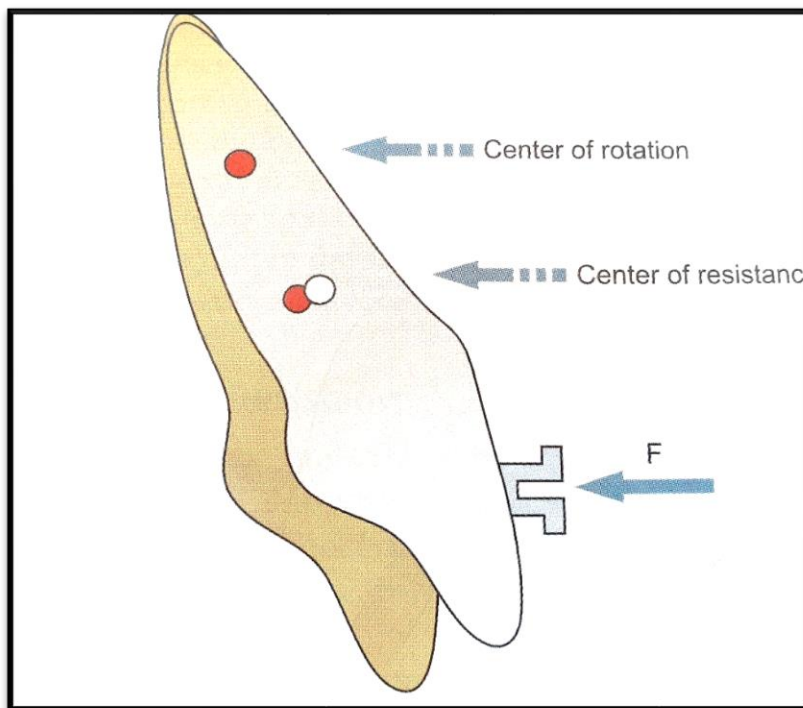


Figure 115: Orthodontic tooth movement (CROT=centre of rotation)

The orthodontic force applied to a tooth is also limited by the biological integrity and health of the tooth and its supporting structures. Any force in excess of the biological capability of the supporting tissues will result in undue sequelae.

Table 2: Force values for different tooth movements

Movement	Force in gm
Tipping	35-60
Bodily movement (Translation)	70-120
Rotation	35-60
Extrusion	35-60
Intrusion	10-20



*Figure 116: Force on the bracket is not in the centre of the tooth*

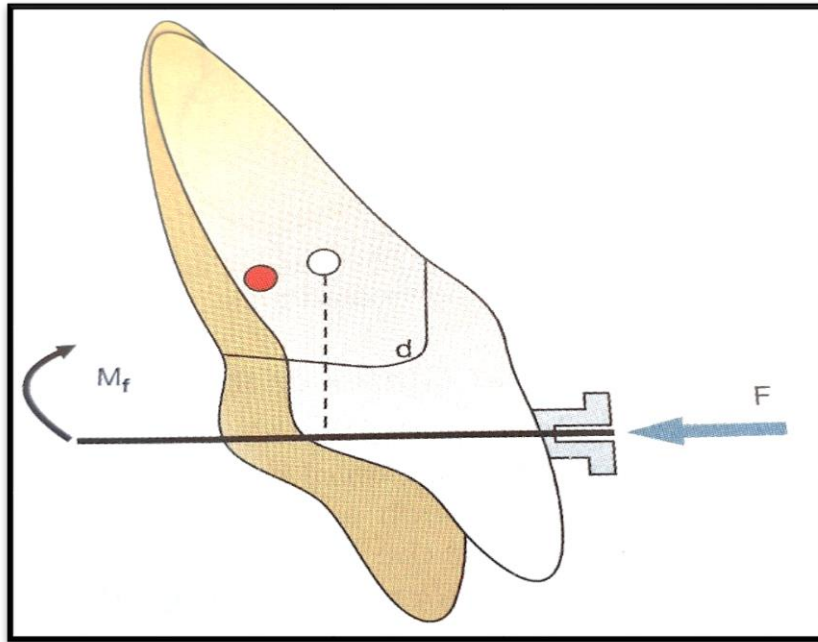


Figure 117: Force on bracket producing a moment about the COR

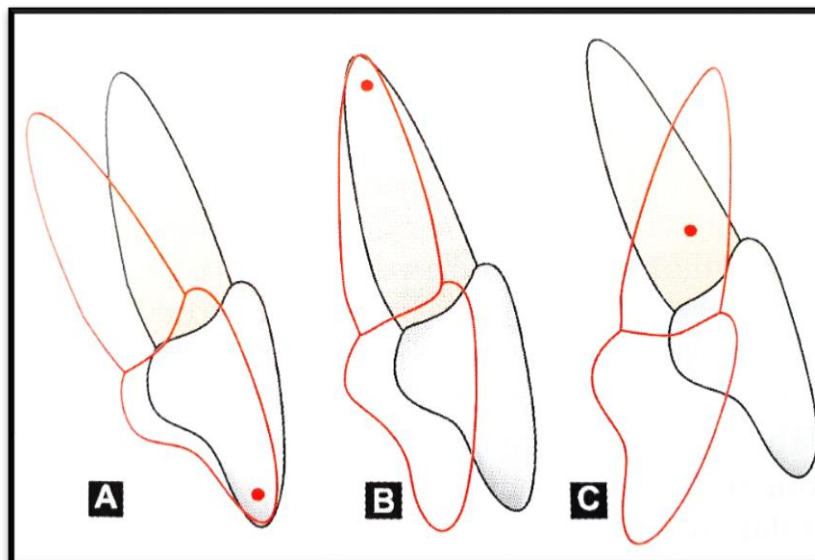
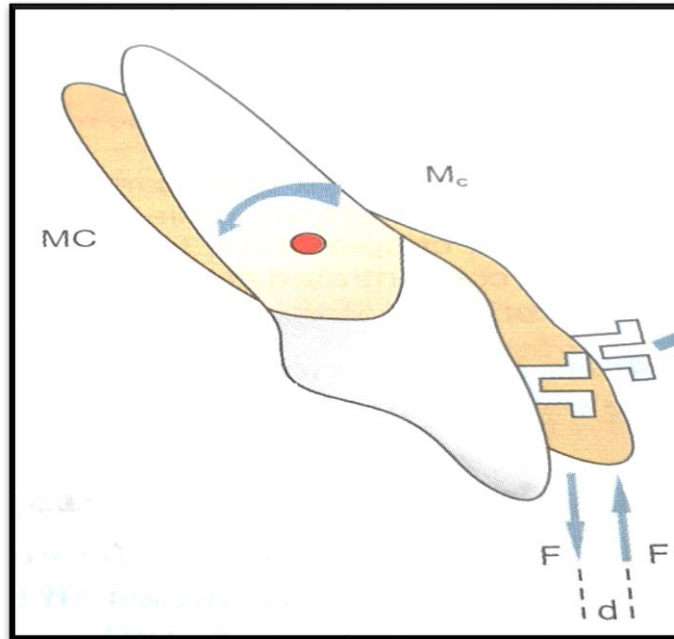


Figure 118: Fluctuations in the centre of rotation



*Figure 119: Torque force producing a moment about the COR*



*Figure 120: A crimpable torqueing spring*

Movement of teeth on the on the horizontal plane can be described as a 'see-saw' motion due to moments caused by the AW bracket relationship and the distance of the force application from the tooth's COR. As this is not a uniform and smooth motion, frictional resistance is created at the bracket slot wire interphase.

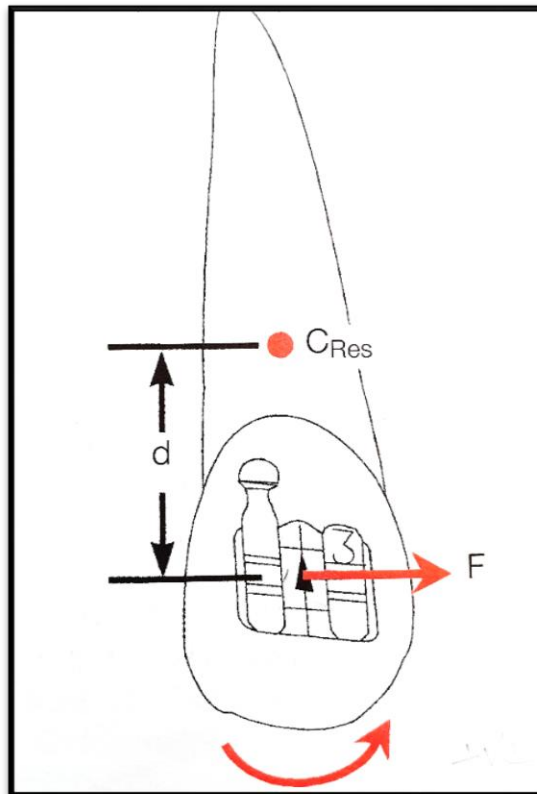


Figure 121: Moment of force in a bracket

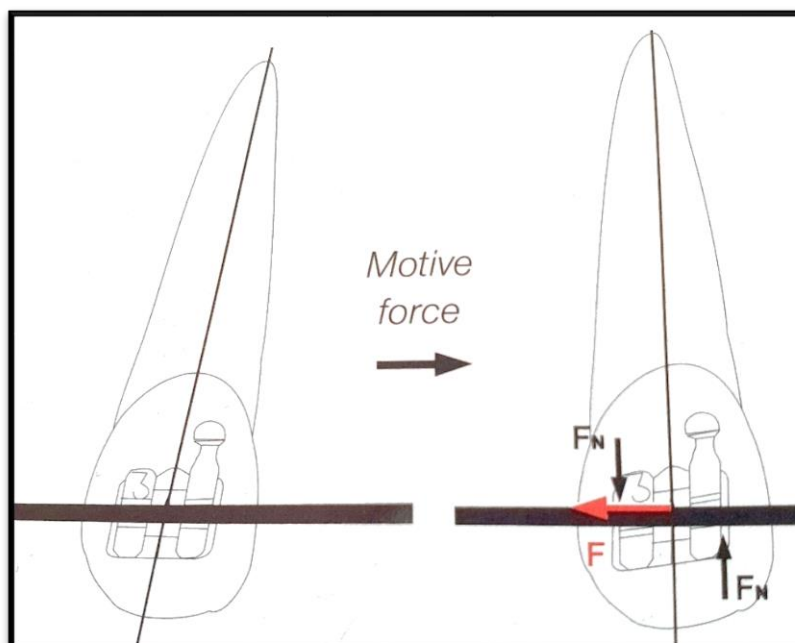
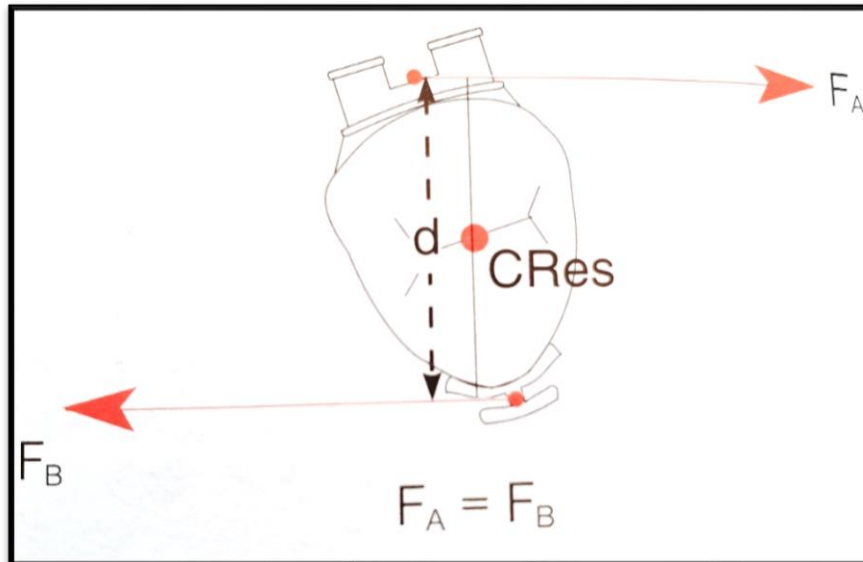
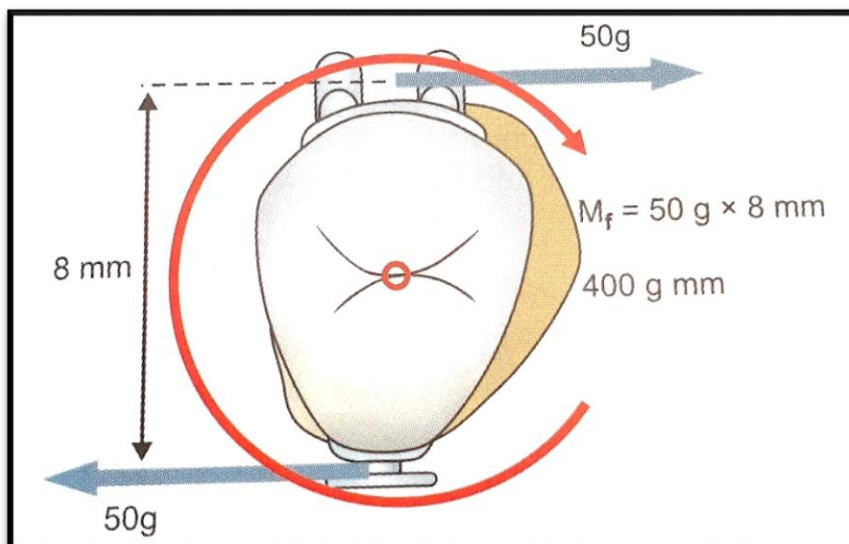


Figure 122: Frictional resistance between bracket and AW

Moments are also created in the derotation of teeth and force couples can be used to balance and cancel the moments during derotation.

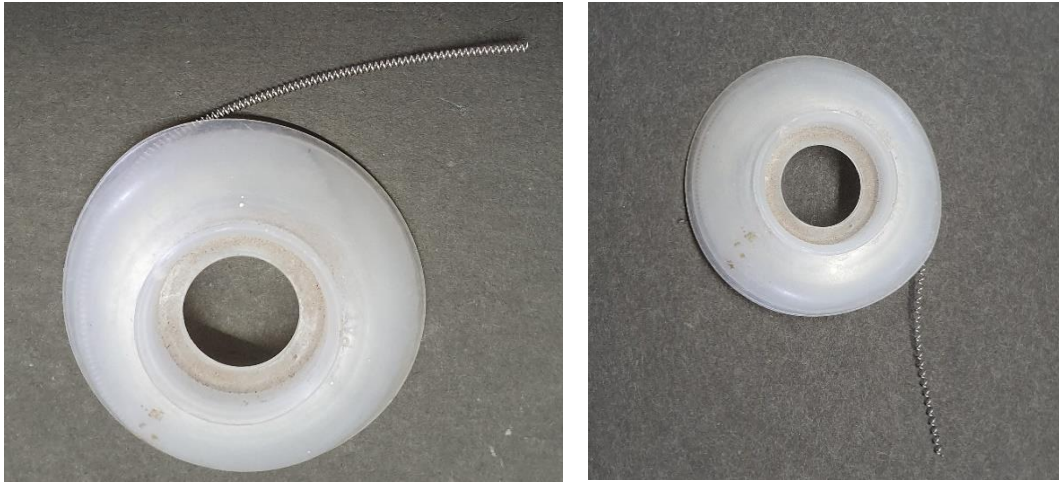


*Figure 123: A force couple to derotate a tooth*

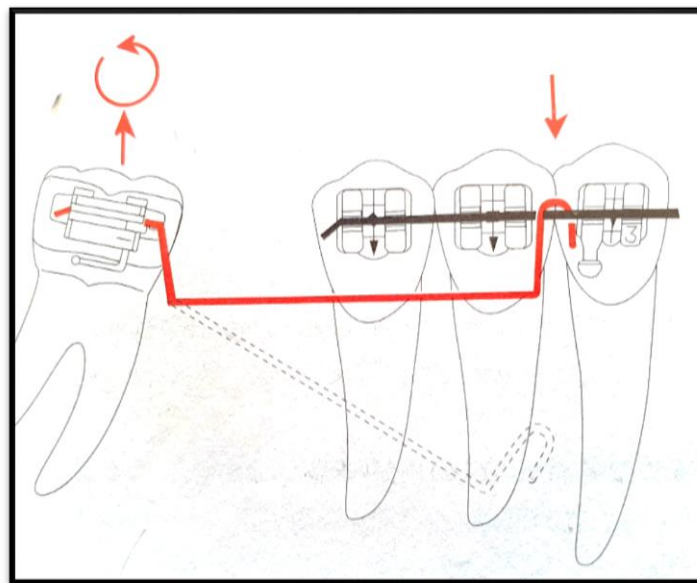


*Figure 124: Moment of force about the COR produced by a derotation couple*

## Springs and Elastics



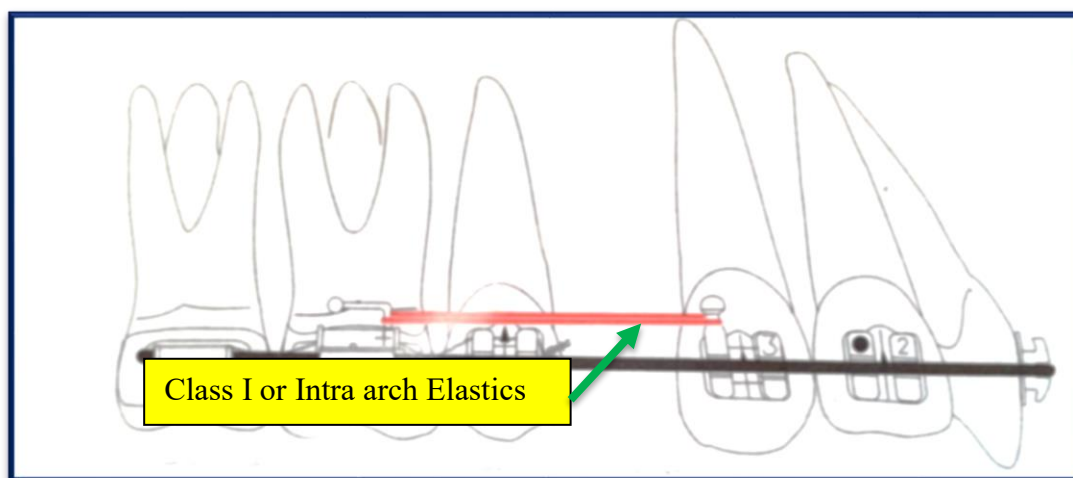
*Figure 125: Closed and open coil spring*



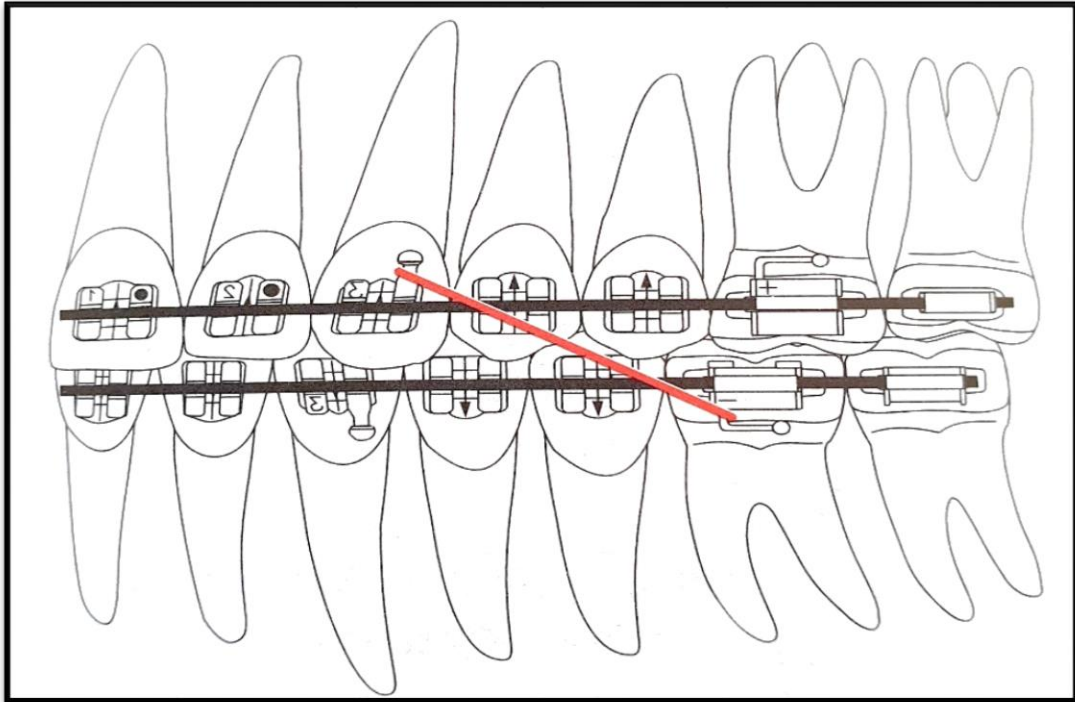
*Figure 126: Cantilever spring to upright a molar*



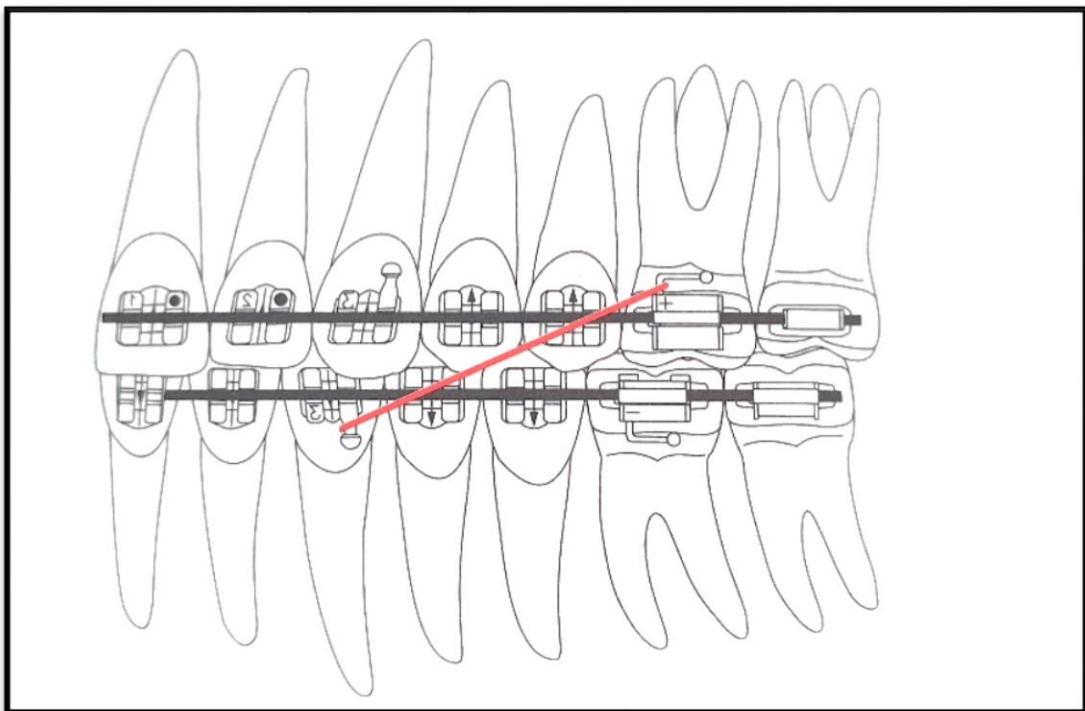
*Figure 127: Elastics and application tool for patient use*



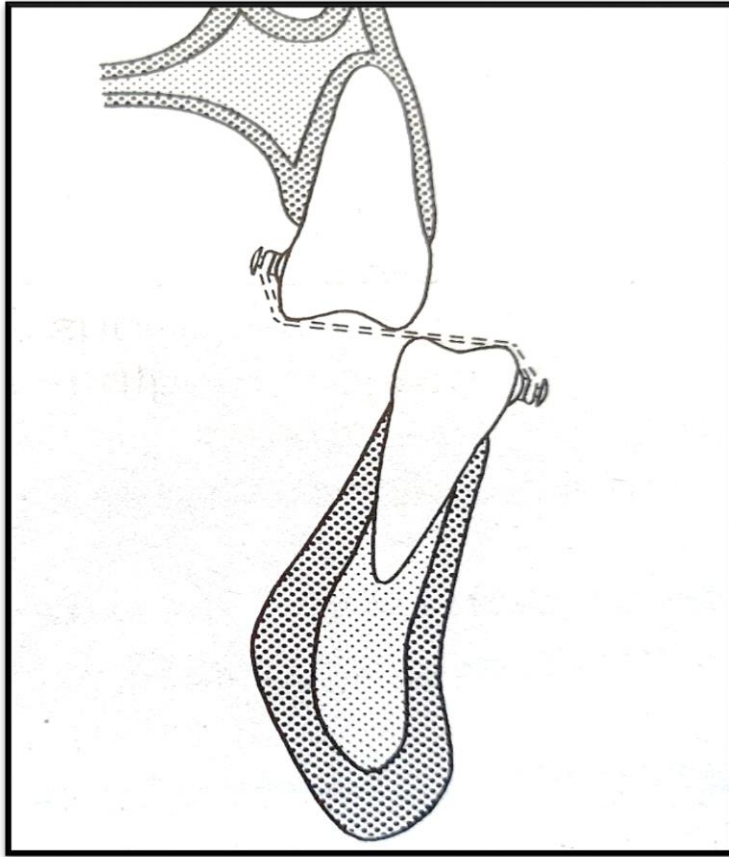
*Figure 128: Class I elastic or PC from molar to canine*



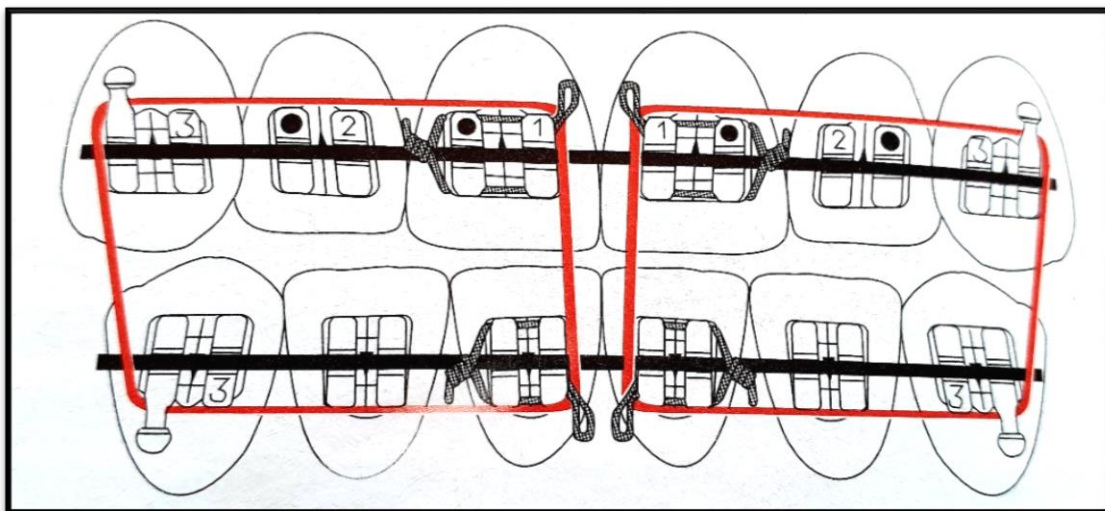
*Figure 129: Class II elastics*



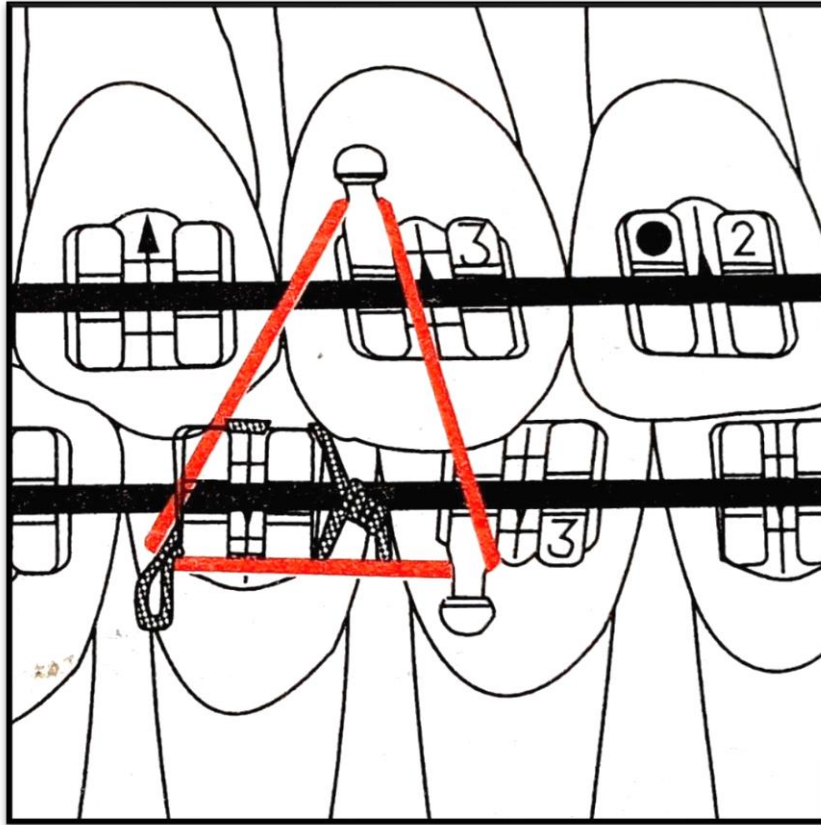
*Figure 130: Class III elastics*



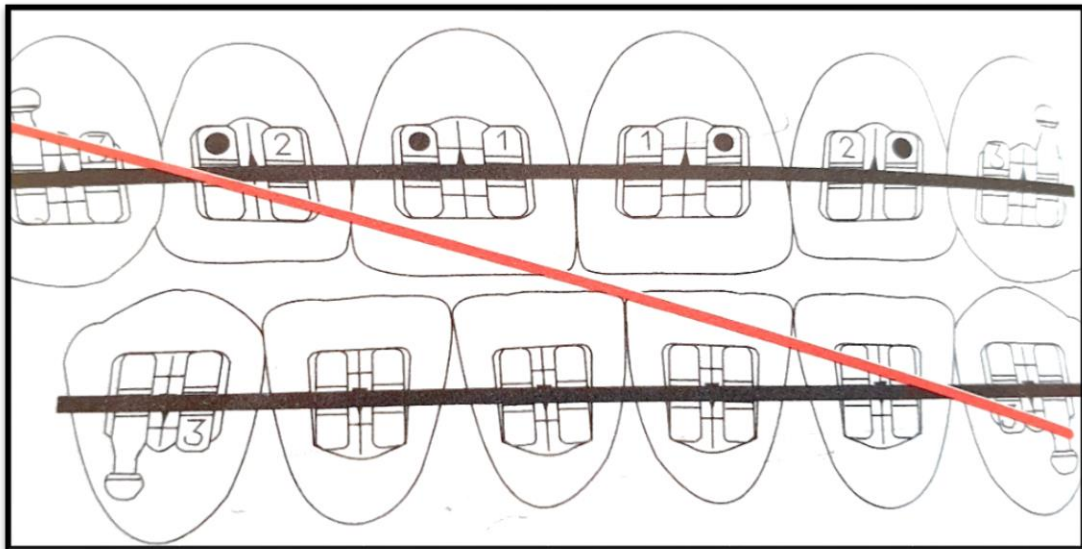
*Figure 131: Crossbite elastics*



*Figure 132: Anterior box elastics*

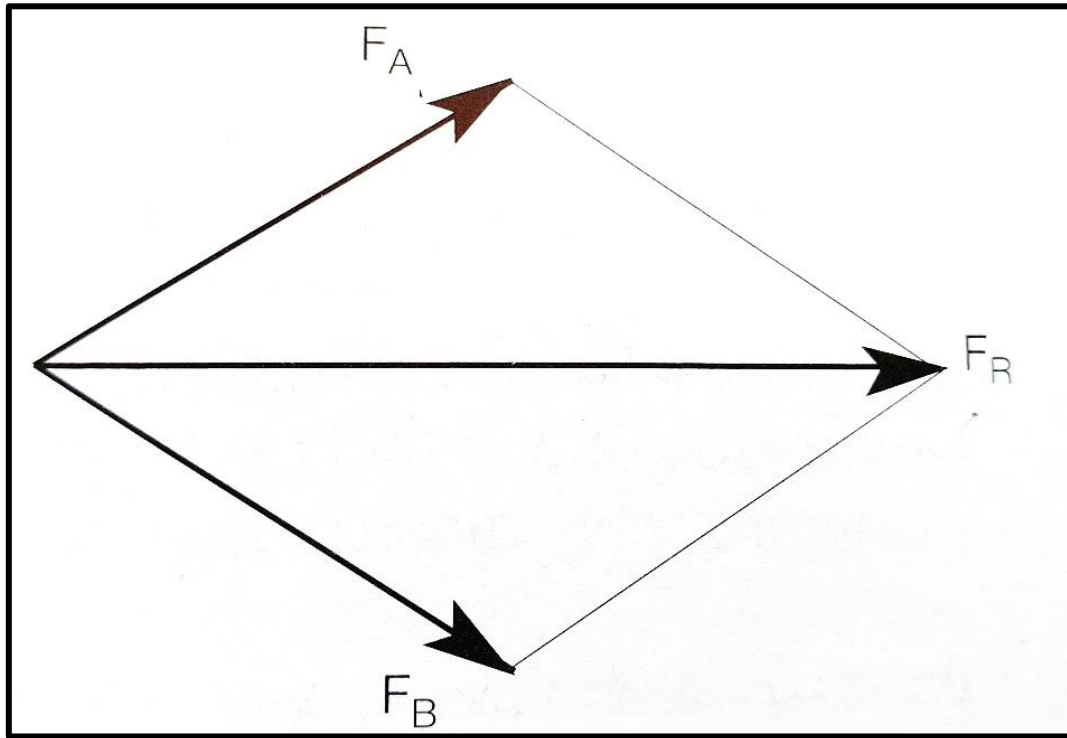


*Figure 133: Anterior triangular elastics*



*Figure 134: Anterior diagonal elastics*

In the case of diagonal forces such as Class II and III elastics or correction of midline asymmetries, both the vertical and horizontal force components of such forces must be considered and resolved.



*Figure 135: Resolution of force components*

## Chapter 9

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### Clinical Applications of the Fixed Appliance

This chapter and discussion only pertains to patients with appropriate facial proportions having a Class I malocclusion. After an accurate diagnosis has been confirmed and a comprehensive treatment plan devised, the fixed appliance can be applied to the teeth to effect the desired objectives.

Always confirm that the patient is comprehensively informed and consents both verbally and in writing to the duration, cost and expected outcomes of treatment. Ensuring that these objectives are met will promote practice goodwill, enhance patient confidence and avert any possibility of a dispute.

The effect that the fixed appliance has on teeth is elementary and mechanical. However, teeth are embedded in living tissues that have their limitations of infringement which if surpassed will result in adverse reactions. It is therefore imperative to have a sound knowledge about the biology of the dentition and the oral cavity.

Use the least amount of force that is biologically permissible to achieve the desired tooth movement. If doubtful about the force magnitude, err on the side of less force than more.

While not comprehensive, a brief description of the clinical situations in which a fixed appliance can be used, is presented:

#### Crowding

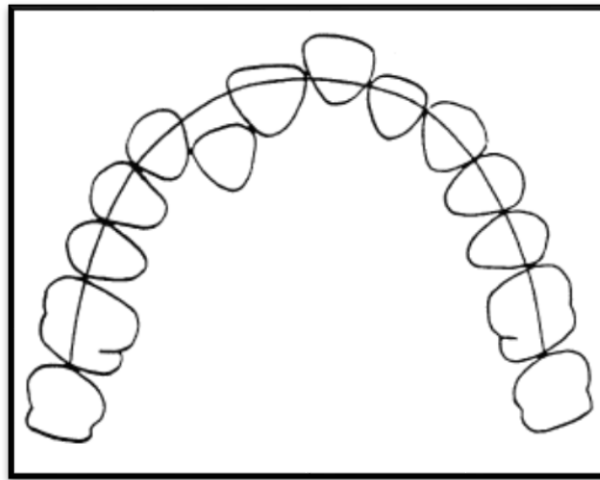
Dental crowding is probably the most common cause of patients seeking orthodontic treatment.

Count the teeth. Count them again and be sure to note which teeth are primary and which are permanent. It is unacceptable to diagnose and devise a treatment plan based on a miscalculation of tooth number and type.

Simply straightening tooth crowns without aligning root support within the bony housing of the alveolus will result in relapse, which will necessitate re-treatment and the possibility of a dispute. The crowns of teeth move in air and can readily be moved within a short period of time. The roots of teeth are embedded in living tissues and moving them in bone is a biological process that cannot be rushed but requires careful consideration and planning. It is an essential requirement for the stability of the result that the tooth roots are embedded and centred in healthy bone and aligned to support the overlying crowns. Tooth

crowns must therefore not be moved into areas where there will not be sufficient bone to support their roots.

Before embarking on a treatment decision in the crowded permanent dentition, determine the amount of space needed to align the teeth. This can be done by measuring (from a study model of the patient's dentition) the sum of the mesiodistal widths from the right second premolar to the left the second premolar of each arch against the arch space from mesial of the right first molar to the mesial of the left first molar, as determined by a malleable but flexible piece of wire. The wire must be moulded in such a way that it conforms to the patient's dental arch and not follow aberrant tooth positions.



*Figure 136: Arch measurement using a flexible wire*



*Figure 137: Treatment of mild crowding with the FOA*



*Figure 138: Treatment of a buccally displaced 13 and 12 in crossbite*

The amount of space required to correctly align the teeth will influence the treatment plan. Generally a space deficit of 2mm to 4mm can be managed by interproximal reduction (IPR) i.e. reducing some of the interproximal enamel of a few teeth, while a deficit greater 4 to 7mm will need expansion of the dental arches. Any space deficit greater than 7mm generally requires some extractions to align the teeth.

A diagnostic setup can be a useful predictor of the final occlusion where the teeth that have been planned for extractions are removed from the casts and the remaining teeth are reset in perfectly aligned positions on the study casts. Currently, this can also be determined with digital intra-oral photography and software.

### **Inter Proximal Enamel Reduction**

Inter proximal reduction (IPR) or slenderisation is a process whereby enamel is removed from the interproximal surfaces of adjacent teeth to obtain space. The process can be confined to the anterior segments, the posterior segments or the entire arch. It can be executed using single or double sided abrasive strips, a safe sided carborandum disk or a thin tapered fissure bur. Depending on the shape of the crown and the enamel thickness the amount of space gain obtained by IPR can be up to 0.25mm per side of a tooth.



*Figure 139: Interproximal abrasive strips*



*Figure 140: A safe sided carborandum disk*

The instruments illustrated above can also be used to alter the shape of teeth. Triangular shaped incisors can render a dark triangular space above the incisal contact while barrel shaped incisors can present with a similar space below the contact point of adjacent teeth. Both barrel and triangular shaped incisors will need modification to create contact surfaces instead of a contact point to improve the dental and gingival aesthetics as well as the stability of the result. Surface contact renders more stability to the occlusion than does point contact. Teeth are less likely to slip past a contact surface than a contact point as the latter offers a smaller area of resistance.

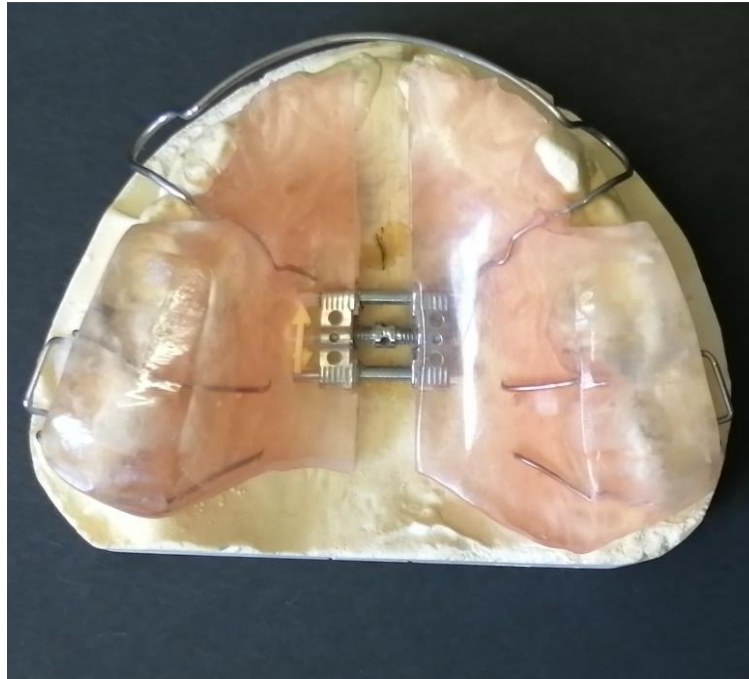
Initial alignment of the dentition should be completed and adjacent tooth contacts must be in line before any enamel reduction is undertaken to circumvent any gouging or ledge formation of the interproximal tooth surface.

## Expansion

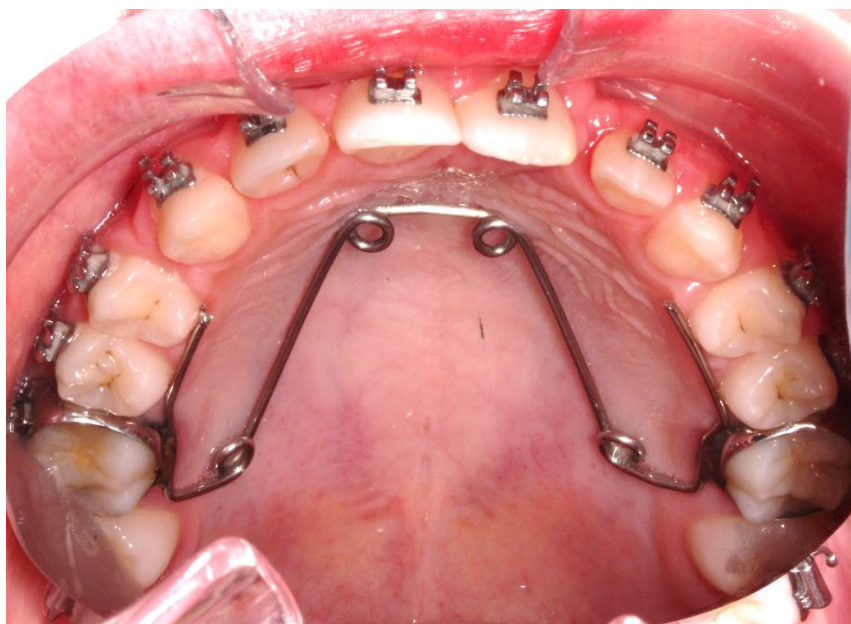
Arch expansion may be necessary to expand narrow arches or for the correction of crossbite; and to gain space for the alignment of teeth. Depending on the amount of expansion needed, lateral arch expansion can be undertaken by the incorporation of either a quad helix or a hyrax appliance or by the use of progressively widened AWs. The quad helix or the hyrax appliances may be used in the upper arch and while the quad helix is soldered to bands on the first molars only, the hyrax is soldered to bands on the molars with extensions that incorporate the premolars either by bands or extensions from the molar bands. Similar to a slow expander on a removable appliance, the hyrax appliance has a centrally positioned expansion screw. The efficacy of both the slow expander and hyrax is dependent on patient compliance, as the screw will need regular activation by the patient. The quad helix is made from 1mm SS wire and is spring loaded on insertion. Additional expansion is achieved by activation of the quad helix in the chair by the operator with a three prong plier.



*Figure 141: The Hyrax appliance*



*Figure 142: A slow expander*



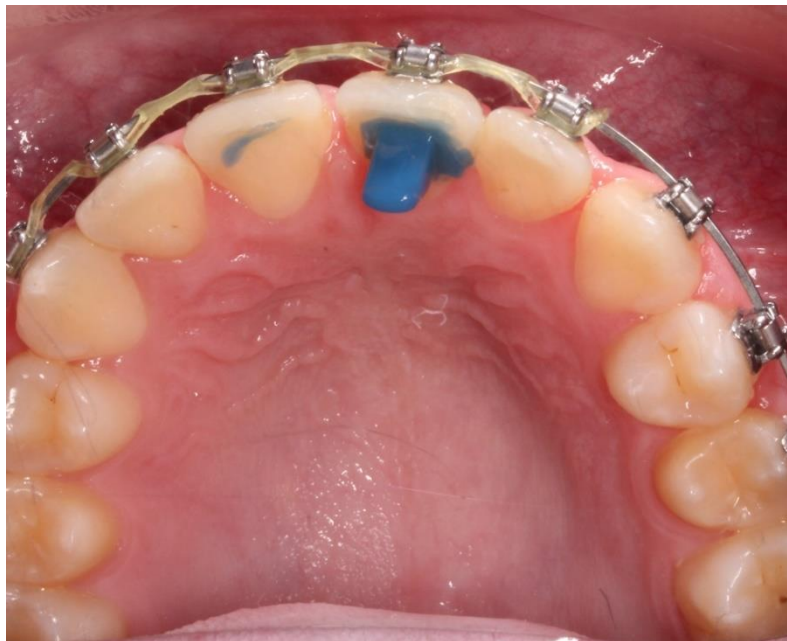
*Figure 143: The quad helix appliance*

Expansion with either the quad helix or the hyrax should be slow and gradual using light forces in order to avoid pain, root resorption and alveolar fenestration or dihesence.

Some arch expansion can also be achieved by widening the AWs before engaging them into the bracket slots. This can commence from the initial 012

NiTi wire and progressively involve subsequent wires up to and including the square SS AWs

For any expansion to be efficient, the teeth need to be free of the interlocking nature of occlusion. The relation of upper and lower dentition imitates a mechanical gear and in order for teeth to move freely the 'gear' has to be positioned in neutral. This can be achieved by adding cement to the supporting cusps of the posterior teeth or by placing bite turbos on the lingual surface of the upper incisors.



*Figure 144: Opening the bite using bite turbos or stops*

## **Extractions**

Extractions are undertaken in orthodontics to relieve crowding caused by an arch length tooth size discrepancy.

As extraction is an irreversible procedure, it should be managed with intense consideration and caution particularly with regard to its effect on facial balance and harmony.

Always locate, identify and count the teeth in a patient's mouth whether visible, absent or unerupted. Any negligence in this process will bear the consequences of either space deficit or space excess.

Some general guidelines that one could consider when contemplating extractions include:

- extracting a tooth closest to the crowded area may not produce the best result (always consider the final position of the dental midlines)
- the periodontal and carious condition of the tooth to be extracted compared to a neighbouring tooth in the arch
- the degree of displacement of the tooth in the arch
- whether a deep or OB is present
- camouflage treatment versus comprehensive treatment as it relates to treatment time and cost
- Patient compliance, consent and assent in the case of minors

A panoramic radiograph is an essential diagnostic aid in planning extractions while a diagnostic setup can help visualize the ultimate result. The stage of dental development will also play an important role in the timing of extractions

**Always keep detailed records of all correspondence with patients and referring professionals.**

If extractions are to be done and the third molars are impacted and symptomatic, it may be prudent to have the extractions and impacted teeth simultaneously removed under general anaesthetic.

There is no conclusive evidence that the presence of the third molars is a cause of orthodontic relapse.

## **Habits**

Although the oral cavity is a dynamic environment, it maintains a state of balance throughout the eruption of both primary and permanent teeth and houses the essential functions of mastication, swallowing and speech. Form follows function, and any practice that interferes with the natural order of development will disturb both physical expression and function. Therefore, any habit that will interfere with the natural order of normal and healthy development must be intercepted and stopped as soon as it is detected or becomes evident.

A common habit that needs to be intercepted immediately is thumb/finger sucking or object biting.

**A thumb/finger sucking habit usually presents with an anterior OB malocclusion and it should be confirmed that the presenting anterior OB is associated with a habit and is not merely a pseudo OB. The latter is a developmental manifestation of the upper and lower incisors erupting toward one another.**



*Figure 145: Malocclusion due to thumb/finger sucking habit*



*Figure 146: Resolution of a pseudo anterior OB*

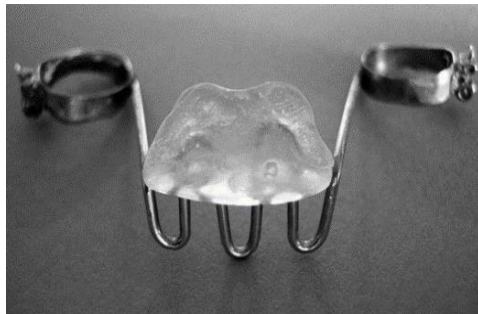
Prior to any mechanical correction of the malocclusion, the habit must first be stopped as any attempt at aligning the teeth is destined to fail. While a Hawley appliance incorporating a tongue gate may be of use in deterring finger sucking, patient compliance may be a problem as the patient can easily remove by the appliance and continue the habit.



*Figure 147: Hawley appliance with a Tongue gate*

A more effective and permanent fixture to remedy the habit is the use of a fixed tongue gate which consist of bands cemented on the upper molars with the tongue barrier made of 0.9-1mm thick SS wire soldered to the bands.

*Figure 148: A fixed Tongue gate*



The appliance should be worn until the patient/caregiver can confirm with certainty that the habit has stopped and the patient should be warned that any recurrence of the habit would cause a relapse of the malocclusion. Only when there is confirmation that the habit has stopped should treatment be instituted to remedy the occlusion.

Sometimes cessation of the habit will be enough to cause closure of the anterior OB and active treatment will not be needed to close the bite.

Nail biting is also a habit that can cause malocclusion and enamel damage. As with, digit sucking, nail biting may also have underlying emotional factors that

contribute to the problem. While the latter may need professional psychological intervention reminders, such as stringent ointments (e.g. 'stop and grow') and nail polish may assist to stop the habit.

Though not a habit, nasal obstruction can also present with an anterior OB and a specific facial form referred to as 'adenoid facies'. Nasal obstruction may be due to allergies or enlarged adeno lymphoid tissue during the developmental years of between six to twelve years. Compensatory mouth breathing occurs as a result with changes in the dentofacial form. As with all mouth-breathers the patient may present with a combination of problems such as anterior OB, enlarged overjet, a posterior crossbite and a narrow deep (steeple) palate.

While the condition warrants an ENT consultation, orthodontic expansion of the palate may assist in opening the nasal passages and correcting the crossbite and overjet. Generally the nasal airway should improve with regression of the lymphoid tissue at the age of twelve years and older.

Although thumb/finger sucking and nasal obstruction may present with similar signs their treatment approach is very different. It is important therefore as in all aspects pertaining to human health that an accurate diagnosis be made before any treatment is initiated.

### **Anterior teeth in crossbite**

When a tooth in crossbite is encountered as in the case of a permanent upper incisor in the mixed dentition, the condition should be intercepted promptly as it will aggravate the malocclusion and hinder jaw growth. In aligning any tooth, particularly those in crossbite, it is a prerequisite that adequate space for the tooth must first be provided. The second important requirement for crossbite correction is that the occlusion be unlocked (i.e. that the bite be opened) so that the tooth in question can be moved freely to 'jump the bite'. This can be done by adding some coloured cement or bonding adhesive to the functional cusps of the first molars.

If conditions permit, the easiest method of correcting an upper incisor in crossbite is to have the patient apply light pressure using a wooden spatula to the lingual surface of the malaligned tooth and pivoting the spatula lightly against the incisal edges of the lower incisors. The applied pressure must be kept very light for no more than five minutes, three times a day and the patient must be monitored weekly to ensure accurate compliance and dental health. Once overjet is established, treatment is terminated and the crossbite correction should be self-retentive if the corrected tooth is in overbite. If the tooth is not in overbite, a Hawley appliance may be used as a retainer for a three to six month period until a positive overjet is established.



*Figure 149: Crossbite correction using a wooden spatula*

The use of a Hawley appliance with a z spring on the infringing tooth is another method of crossbite correction. The appliance should incorporate a posterior bite plane to free the occlusion and the z spring activated to allow the tooth in question to jump the bite.



*Figure 150: A Hawley appliance incorporating a Z spring*

A fixed appliance is however more efficient in achieving the required tooth movement as it reduces the dependency on patient cooperation. In the presence of the required amount of space for the tooth to be moved out of the crossbite, the fixed appliance for a single arch in its most basic form, consist of seven brackets (i.e. a bracket on the tooth in question and three brackets on either side of it). Progressively thicker wires commencing with a 0.012" Niti are then applied and changed at four to six week intervals until the tooth has reached the planned position.

In difficult cases complicated by a severely displaced tooth and crowding, it may be prudent to band and align the arch first, progressing from a 0.012" NiTi to a 0.016" SS. A 0.016" SS Australian wire with two vertical loops adjacent to the tooth in crossbite is used as the next AW. The horizontal segment between the two loops of this AW will be passively distant and labial to the tooth in crossbite. With some tension, this bar is then engaged to the bracket on the tooth in crossbite and will force the tooth forward out of the crossbite.



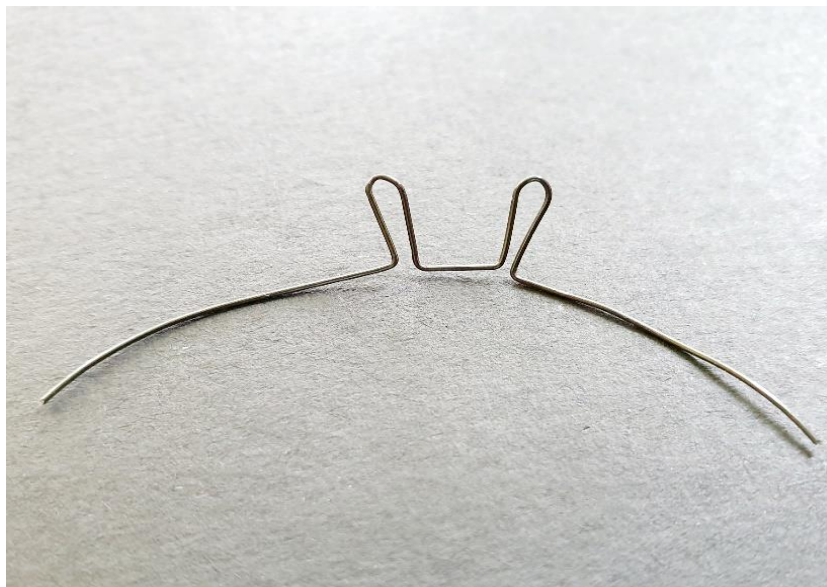
*Figure 151: Crossbite in centric occlusion and in centric relation*

The bi-vertical looped AW can also be adapted to correct one to four anterior teeth in crossbite. If several adjacent anterior teeth are in crossbite, the entire arch is again banded and once the bracket slots are aligned using the standard wire sequence, vertical loops may be added to a 0.016" SS AW on either side of the segment that is in crossbite. Opening both vertical loops by equal amounts will activate the arch and stops are added to the AW in front of the buccal tubes on the first molars to prevent the wire from slipping through the buccal tubes and becoming passive.

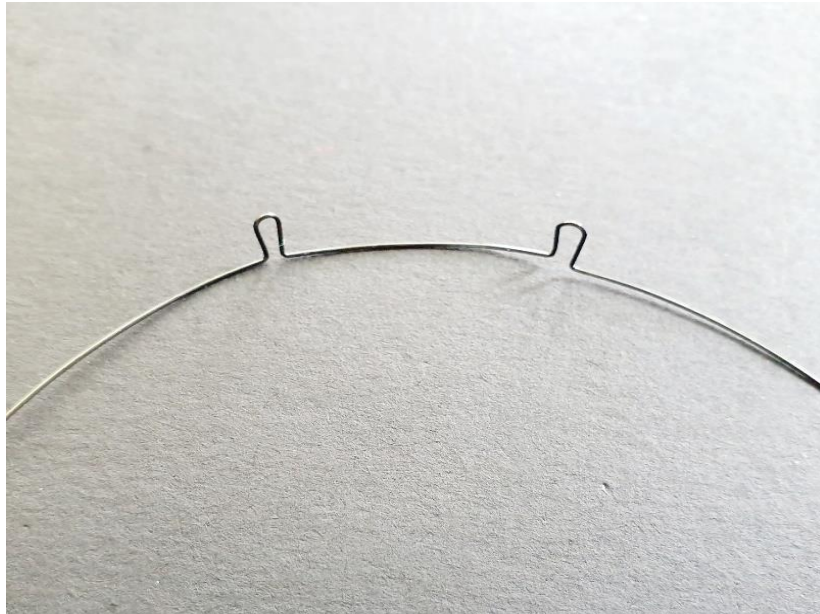
Because the AW will be larger (by no more than 3mm away from the labial surface of the teeth in crossbite) than the patient's arch after activation, it is ligated with some tension with SLs to the brackets on the anterior teeth that

are in crossbite. This will cause a forward expansion force on the teeth. Due to their anchorage capacity and the stops that have been placed in front of them, the molars will offer resistance and as the AW releases its tension, the anterior segment will be displaced anteriorly out of the crossbite.

Unlock the occlusion before crossbite correction and to return the same once the crossbite is remedied.



*Figure 152: Vertical looped AW for a single tooth in crossbite*



*Figure 153: Vertical looped AW for multiple teeth in crossbite*

Another method of dragging a tooth out of crossbite is to use a Begg bracket as an intermediate attachment to the tooth and ream elastic thread through the bracket's vertical slot and tie it with some tension to an attachment loop on the AW.

A utility arch is another design that may be used to correct a crossbite. It favours situations in which the premolars need to be bypassed as when there are unerupted or partially erupted buccal segments. Its mechanism of action is based on the same principle as the bi-vertical looped arch described above i.e. a larger AW placed under tension into a smaller arch with resistance to movement (anchorage) offered by the molars.

Before any tooth movement is initiated, it is important that the brackets on all teeth be perfectly aligned. This is achieved by meticulous bracket positioning on the teeth and having the patient wear a sequence of wires from a 0.012" Niti to a 0.016" SS. Attempting to move teeth along the arch on anything less than a 0.016" SS will cause the AW to buckle creating friction and prevent tooth movement or result in undesirable tooth displacement.

Any crossbite correction will necessitate opening of the bite. This may be attained by using a removable appliance with posterior bite blocks or specialised orthodontic attachments such as 'bite turbos'. The most accessible and convenient method is to apply a 2-3mm thick blob of coloured light or chemical cure cement to supporting cusps of the posterior teeth to free the occlusion and allow the malposed tooth to jump the bite. Once overjet of the teeth in

crossbite is achieved, the cement can be removed so that anterior overbite can be established making the correction self-retentive.

If overbite is evident after crossbite correction, the achievement will be self-retentive. If not, a Hawley retainer must be provided until the corrected teeth establish overbite.

A step down bend in the AW on an upper tooth after it has been moved out of the crossbite will aid in having the tooth develop a positive overbite.

Additional caution should be exercised in managing a lower incisor in cross bite. Apart from the two primary requirements of space and freedom of movement, the stability of the tooth must be considered as the alveolar and periodontal support may be compromised. The tooth may be mobile. There may be gingival recession dehiscence, supra-version or a combination of these signs.

Multiple lower incisors in cross bite are indicative of a Class III skeletal relation and will necessitate specialised care. It is therefore important that in the case of lower incisors in crossbite, a thorough assessment is done and a careful treatment plan is devised.



*Figure 154: Crossbite correction and alignment of canine (13)*

## **Open Bite**

OBs may be present anteriorly or laterally. An anterior OB (AOB) may be dental, skeletal or a combination thereof. Because the last two conditions will need orthognathic intervention and specialised care, this discussion will only focus on AOBs of dental origin.



*Figure 155: An AOB that can be managed orthodontically*



*Figure 156: An AOB in an adult that requires surgical intervention*

The size of an AOB varies and is described in mm by the amount of negative overbite. As with all conditions of illness, it is important that the cause of the ailment be removed for the treatment to be successful. If thumb/finger sucking or object biting is the cause of the AOB, then this habit should first be stopped before any active treatment is initiated. Patient education and motivation supplemented with a fixed tongue gate for a period of three to six months should help to eliminate the habit. Some bite closure in response to the tongue gate may also occur.

A 'pseudo AOB' does not need any mechanical intervention as it is a natural developmental phenomenon seen during the early eruptive stages of the upper and lower permanent incisors growing toward one another.

Before embarking on active treatment to close the bite, it is important to visualise and anticipate the lip and gum lines as these will impact on the patient's ultimate smile.

After the initial phase of aligning all the bracket slots, the bite may be closed by a slow eruptive process of the incisors using reverse curves swept into Niti wires of 0.016" thickness progressing to thicker wires. These wires may be applied to the upper arch, the lower arch; or both as dictated by the final lip and gum lines.

The reciprocal force of a reverse curve AW on the posterior teeth is that the AOB may be aggravated due to an extrusion of the molars. To counter this reactive force, a TPA and/or a LA may be used to anchor the molars. Another anchorage method is to tie the molars down with SLs to buccally and lingually placed TADs. A simpler and sustainable counter to the reciprocal force on the molars is to prescribe a sugar free gum chewing regimen of one to two hours per day. In some cases the latter prescription without any active treatment can be enough to intrude the buccal occlusion and close the AOB.

In cases where it is necessary to bypass the premolars and even the canines from the bite closing procedure, a plain arch or utility bent from 0.016" SS wire with tip up bends in front of the lower first molars and tip down bends in front of the upper molars can be used.

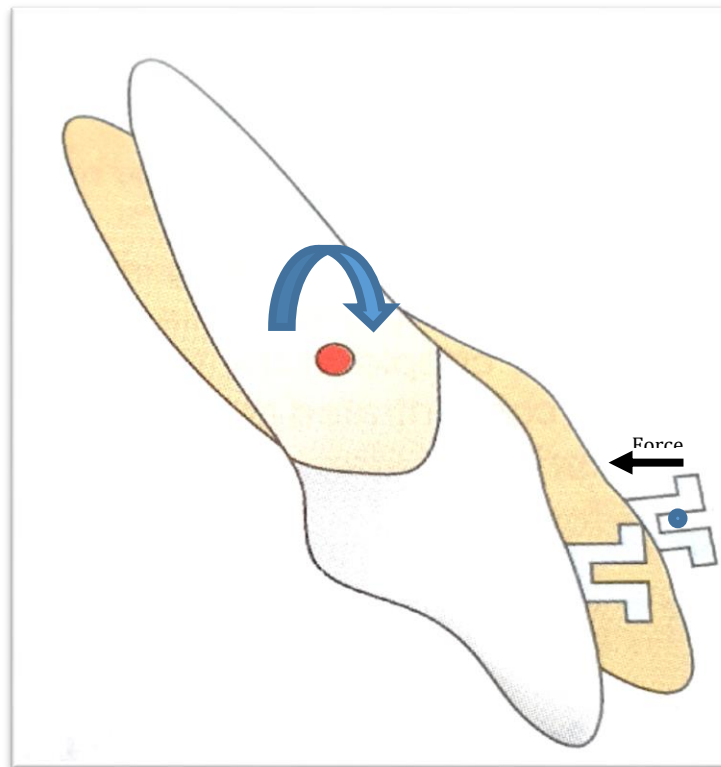
Before ligating any wire intended to close an AOB, one must first engage it into the buccal tubes of the first molars on the intended arch and verify that the anterior perimeter of the AW will extrude the incisors of that arch. Ideally the anterior perimeter of the AW should passively lie 3mm below the upper incisors for upper extrusion and 3mm above the lower incisors for lower extrusion.



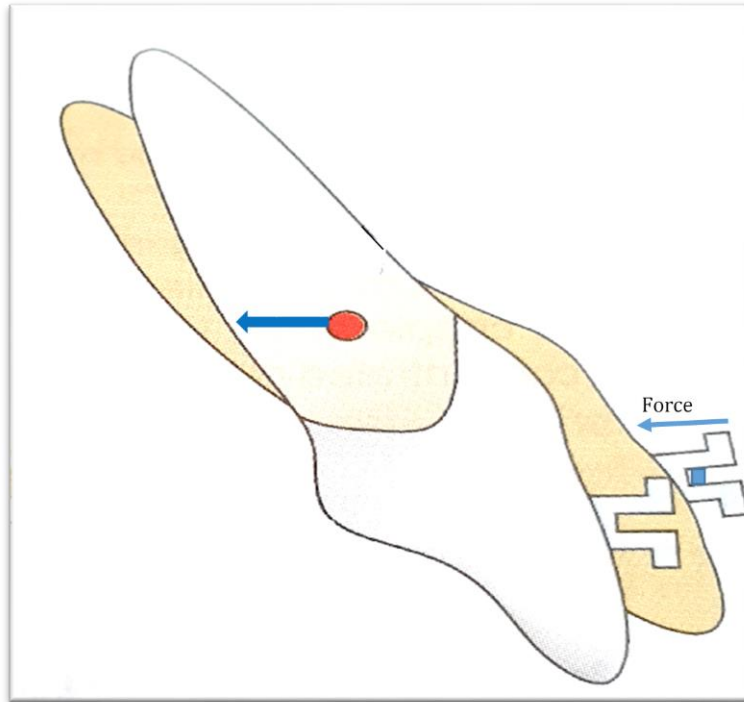
*Figure 157: Reverse curved NiTi AW before ligation to the upper incisors*

The wires are then engaged into the incisor brackets under some tension and ligated.

Moving teeth on a round wire adds a moment of force to the tooth and can alter its torque. This means that over and above the intended extrusive force on the tooth, the tooth may -because of the square bracket /round wire relationship- rotate about the wire. Any such movement alters the tooth's root torque and should be noted, monitored and addressed.



*Figure 158: Round wire in a square bracket causing rotation about the COR*



*Figure 159: Square wire in a square bracket causing translation about the COR*

Up and down elastics of a ¼" 2 oz size, either in a box, triangular or zigzag arrangement on a SS sectional wire or a full Niti wire of 0.016" thickness or thicker is another approach that may be employed to close an AOB.

Once closed, the achievement must regularly be monitored and maintained by an extended gum chewing regimen, as there is no specific retentive appliance for this situation. Proprioceptive stimulation from the establishment of incisal contact may initiate positive neural feedback to maintain bite closure.

Finally, because the upper and lower incisors may not have been in contact since their eruption, the mamelons of these teeth will still be evident and obvious. These may be selectively reduced with a tungsten carbide bur to give the teeth a mature and worn appearance.



*Figure 160: Mamelon reduction – before and after treatment*

### **Deep Bite**

A deep bite is most commonly seen in Class II patients and should therefore be concurrently managed by a specialist. Some patients may require multidisciplinary intervention by an orthodontist and a maxillo-facial surgeon.

In brachyfacial (horizontal growing) patients erupting the buccal segment will assist in increasing lower facial height and reducing the overbite. Disoccluding the molar teeth to promote their eruption may do this. While a Hawley appliance with an anterior bite plane can be useful, bite turbos or a small bead of bonding cement fixed to the lingual surfaces of the upper incisors can also be used to induce a posterior OB and initiate molar eruption.

Levelling the curve of Spee by engaging the second molars in the AW will assist in opening the bite.

Ideally one should aim for a 2mm incisor overbite and once achieved, appliance wear should discontinue.

### **The rotated tooth**



*Figure 161: Gingival fibres of a rotated tooth*

While the current pre-adjusted bracket modifies tooth position with respect to the first, second and third order bends, with the exception of the Alexander bracket, it does not address tooth rotations. Rotational adjustments is not an inherent property of the pre adjusted Siamese edgewise orthodontic bracket. Rotational malposition of a tooth would require additional adjustments to the fixed appliance as described below:

*1. Bracket position.*

The bracket placement should favour the rotated side of the tooth i.e. distally on a distobuccally rotated tooth and mesially on a mesiobuccally rotated tooth



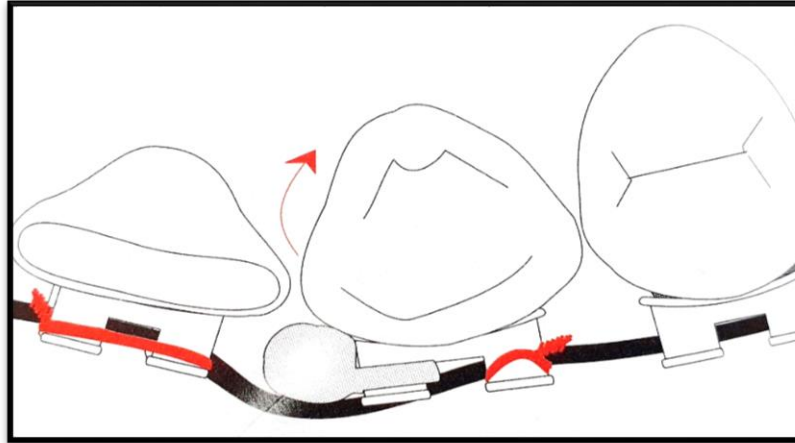
*Figure 162: Bracket position on a rotated tooth*

*2. Wire bends.*

In steel wires of up to 0.016X0.022" selective bends may be placed in the segment of the wire that is attached to the rotated tooth such that one side of the tooth turns out and the other side in.

*3. Rotation wedges.*

Rotation wedges, SLs or dounuts may be added to the tie wings on one side of the bracket before engaging the AW into the bracket slot. After the AW is ligated with a SL into the slot, a greater amount of pressure will be exerted on the side where modifications to the bracket rings have been added and the tooth should rotate in that direction.



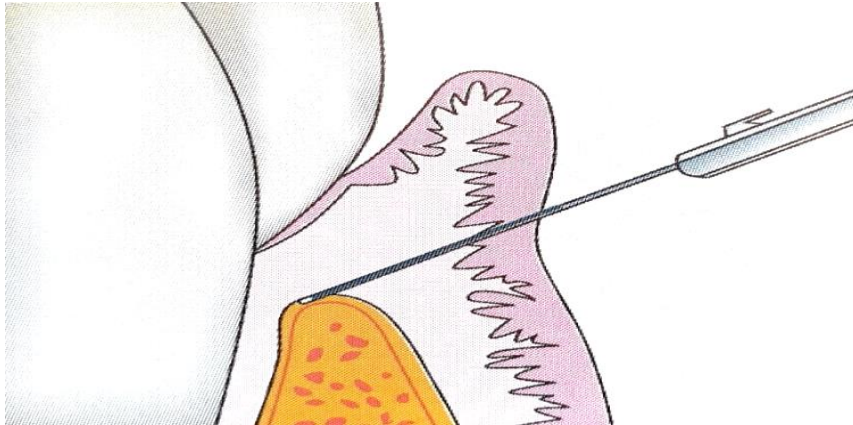
*Figure 163: Rotation wedges to rotate a tooth mesially*

#### 4. A force couple.

Another method to derotate a tooth is by the application of a force couple i.e. a force is simultaneously applied to the tooth in one direction on the buccal side and in the opposite direction on the lingual side.

Derotated teeth have a tendency to relapse due to an abundance of fibres around the neck of a crown. Retention of derotated teeth should therefore be fixed for an extended period of three months or more.

A supracrestal fiberotomy is a minor surgical procedure that may be undertaken in the dental chair to reduce the potential for relapse of derotated teeth. It entails an incision with a No. 2 surgical blade in the gingival sulcus around the circumference of the crown to sever the stretched circular gingival fibres.



*Figure 164: Supra-crestal fiberotomy*

### **Midline discrepancies**

Upper dental midline deviations are more perceptible than the lower because of lip elevation during facial expression. Midline shifts are a result of an uneven space distribution between the right and left halves of the dental arch. Crowding of one half of the arch may cause the midline to cross over to that side. The midline will also move over to the side that has surplus space which may be due to a missing tooth, an unerupted tooth or a severely displaced tooth.



*Figure 165: Midline shift due to a displaced canine*

Treatment of midline discrepancies should be approached with caution as they can prove cumbersome to manage. An obvious and severe midline shift will necessitate the extraction of a premolar, usually the first premolar, to provide adequate space for the midline to be re-centred.

Extractions are irreversible and decisions to extract teeth must be made holistically taking into account space requirements, anchorage, midline position, function, aesthetics and the resulting occlusion. A diagnostic setup is a useful predictor of the final dental arrangement and should be employed to assist with

the extraction decision. This exercise is usually done with study casts but can also be done digitally on a computer.

Once space has been made available, the bracket slots aligned, and adequate anchorage has been prepared, sliding mechanics can be employed to move the midline over, one tooth at a time, starting with the canine followed by the lateral incisor and finally the central incisor. Each tooth that is moved back to centre the midline, should be incorporated into the anchorage system so that the intended midline adjustment occurs, and anchorage is not lost.



*Figure 166: Midline adjustment due to missing 13*

Moving more than one tooth at a time can strain the anchor unit causing anchorage loss. The space created for midline adjustment will be lost, making the entire process ineffective.

Once the midlines are aligned, the anchor can be released and residual space can be taken up by moving the posterior teeth forward. This is done by setting up the anterior teeth as an anchor unit and moving the posterior teeth one at a time.

Be sure to use full thickness square SS wire as a final wire to obtain maximum expression of the tip and torque of the tooth. This will align the root with the crown and minimize relapse.

Finally a fixed canine to canine (three to three) retainer may be cemented to the lingual surfaces of these teeth to retain them in their newly acquired position.

### **Central and other diastemas**

Spacing of the front teeth is commonly seen in patients with an interfering frenum, a mesiodens; or in patients who have a Bolton discrepancy. The latter may present as a central diastema or as general spacing between the incisors.

The management of a diastema will depend on the underlying cause of the problem

Space is normally present between the upper central incisors during the early mixed dentition stage. Attempts should not be made to close this space, as it is due to the eruption pathway of the maxillary canines which commences in a horizontal direction and causes a convergence of the root apices of the incisors with a resultant mesiodistal splaying of the crowns referred to as the 'ugly duckling' stage of dental development. The spaces between the incisors usually close and are taken up when the canines on their eruptive pathway reach the roots of the lateral incisors and are diverted downward into the oral cavity. The change in position of the erupting canines from a horizontal to a vertical position will release the pressure on the incisor roots and together with the compression of the erupting canine crowns on the incisor crowns will close any spaces between them. Any abnormality or defect in canine eruption will disrupt incisor alignment and will need specialised care.

An absence of the 'ugly duckling' spaces is indicative that there will not be enough room for the unerupted canines to align and that the arch will be crowded

It is important in all cases to count all teeth and to take note of which teeth are present and which are absent. An orthopantomograph is an essential diagnostic aid to confirm the overall dental status and to help in determining the aetiology of the patient's dental condition.

A mesiodens must first be removed before any attempt is made to close the space.



*Figure 167: Resolution of space caused by two supernumeraries*

Ideally an enlarged frenum should be excised after space closure. If the surgery is done before space closure the resulting scar tissue may impede tooth movement and closure of the diastema.

Impacted canines should be managed by a multidisciplinary team consisting of an orthodontist and other dental specialists.

If the impacted canines are in their ideal position and their root formation is incomplete as determined radiographically, extraction of the primary canines may be all that is required to encourage eruption of the impacted canines. Final alignment can be done with a fixed appliance once the teeth have erupted into the oral cavity.

Because the erupting canine will be much higher in the maxilla or lower in the case of the mandible, than the adjacent teeth, 0.012" NiTi can be used for the alignment of the teeth. Due to its high elasticity and light force a 0.012" NiTi AW will not strain the biological environment and will not detach the bracket from the tooth. As the tooth is progressively dragged to the occlusal level, the bracket position will need progressive repositioning until the crown has reached its ideal position in the dental arch.

Whenever bandings are done on patients where the full complement of brackets are not used, as in patients with extracted or missing teeth, it is expedient to save the bracket and use them as intermediate attachments as described above until the tooth is in its ideal position and ready to accept its intended bracket.

Diastemas or spacing due a Bolton discrepancy require careful analysis of tooth and arch size and correlation with the opposing arch to identify which dental arch has excessive or deficient tooth material.



*Figure 168: Closure of multiple diastemas*

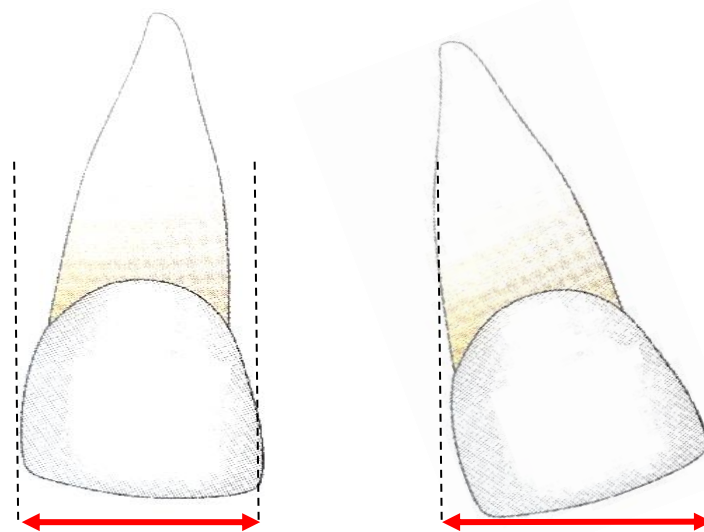
In essence, large teeth on the maxilla will present as crowding of the upper teeth or spacing of the lowers, while large teeth in the mandible will present as crowding of the lower teeth or spacing of the upper teeth.

Mild spacing between the upper incisors due to a Bolton discrepancy can be managed by stripping the lower teeth or extracting a lower incisor. The created spaces in the lower arch are then first closed making this arch smaller, and the 'larger' upper arch is then compressed using smaller AWs, and wrapped around the smaller lower arch, eliminating the interdental spaces in the upper arch.

If a decision is made to remove a lower incisor, it should be the most displaced of the lower incisors and the patient should be informed that they will not have a lower midline at the end of treatment. Removing the most displaced tooth will enable smooth, rapid and effective alignment of the remaining incisors in healthy bone.

Repositioning the crown of a displaced tooth is easier and takes a lot less time than aligning the root of such a tooth. Poor root alignment i.e. not placing the root directly beneath the crown to support it,, will lead to relapse.

Bracket position on the tooth can also be manipulated to change the mesiodistal width of the crown. An incisor that has tipped more mesially will occupy more space than a tooth that is positioned straight and upright. Therefore, gentle and selective tipping of incisors can camouflage mild spacing between teeth.



*Figure 169: Tipping a tooth to take up space*

Relapse and spacing is always a possibility and due consideration should be given to the tongue size and activity. Dental indentations on the tongue borders can be indicative of an enlarged or overactive tongue. This could cause the teeth to separate again and patients should be warned of this possibility.

### **The intruded tooth**

Occasionally a tooth may be intruded. Its occlusal surface would be more gingival than the adjacent teeth. Before commencing any treatment it is important to establish why the tooth is below the occlusal plane. It may be due

to delayed eruption, crowding, an incisal fracture or ankyloses. Minor orthodontic treatment can assist in levelling such a tooth in the first three instances while an ankylosed tooth would need specialised surgical and orthodontic care.

If there is a space deficit and partial impaction of a tooth occurs due to encroachment by adjacent teeth, then space would need to be made available before the tooth is aligned. A minor deficit of one to two millimetres might be achieved during the alignment process, by IPR of adjacent teeth or by the use of separating elastics mesial and distal, to the displaced tooth. An open coil spring may also be reamed into the AW, or a bi-helical spring can be used between the brackets adjacent to the intruded tooth so as to push them apart to create the necessary space.

The tooth may be aligned occlusally with the FOA by either positioning the bracket on the affected tooth more gingivally if NiTi wires are used, or by placing a step up bend in a SS AW.

Upon completing the orthodontic treatment the patient may need some gingivoplasty to contour the gingival margin of the affected tooth. The gingiva is always dragged with the extrusion process so that the marginal gingiva of the treated tooth will be at a higher level than the adjacent teeth. A fractured tooth that has been extruded to render more crown will need general dental or prosthodontic follow-up treatment.

### **The extruded tooth**

A tooth can also be at a higher occlusal level than adjacent teeth. It may have over erupted when the opposing tooth in the opposite arch is absent or grossly carious. If the over eruption is minimal (1-2mm) the tooth may be realigned with the FOA to the occlusal plane of the arch by reversing the mechanics described above for an intruded tooth with the exception that the intruding force be kept to a minimum (50g) to avoid any sequelae resulting from compression of the neurovascular supply at the root apex.

### **Missing teeth**

An absent tooth in the dental arch may be managed by either opening the space for a prosthetic replacement or closing the space by substituting adjacent teeth into the space. After confirming that there is not an unerupted tooth or an embedded obstruction beneath the space one should consider the size of the space and the configuration and position of the roots of the teeth adjacent to the space, as well as the condition of the bone.

If an embedded tooth is present the patient should be referred to a specialist to open the space and erupt the tooth.

In the absence of any malocclusion, spaces that equal the size of a premolar should be maintained and can even be opened further when root uprighting of

adjacent teeth is undertaken. A multidisciplinary approach would assist in replacing the tooth with an implant and prosthesis.

If the midline is centred, smaller spaces can benefit by orthodontically moving the posterior dental segments forward into the space. Bone density and root morphology and position will have an influence on the speed of the procedure. Once the space is closed it is important to ensure that the roots have been uprighted and are in line with the tooth crowns to avoid the possibility of relapse.



*Figure 170: Rx of missing 13 and midline displacement*

### **Supernumerary teeth**

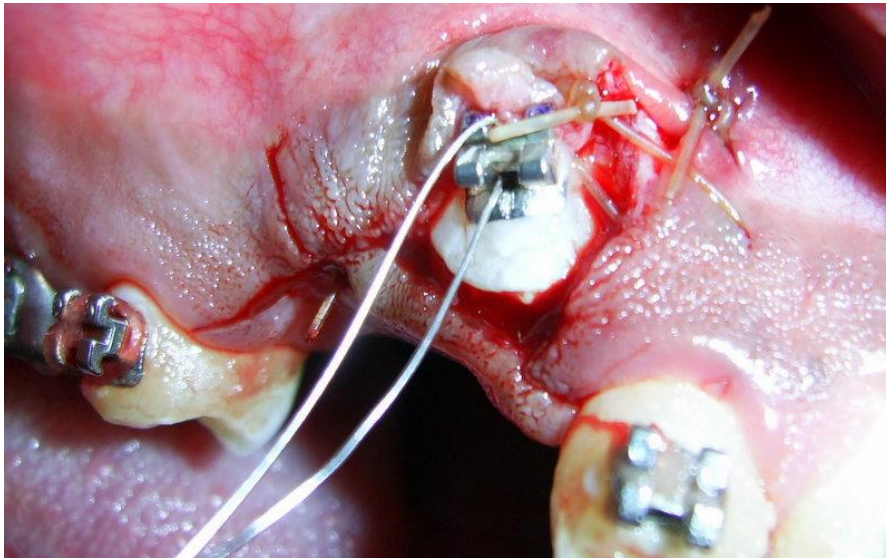
These may be single and isolated or they may be multiple as seen in syndromes such as cleidocranial dysostosis. The latter would need specialized care.

Whether erupted, partially erupted, or fully erupted a detailed analysis of the patient's crowding or spacing should be done. This, together with the crown and root morphology of the supernumerary tooth as well as the condition of the surrounding bone will dictate whether the tooth should be retained or extracted.

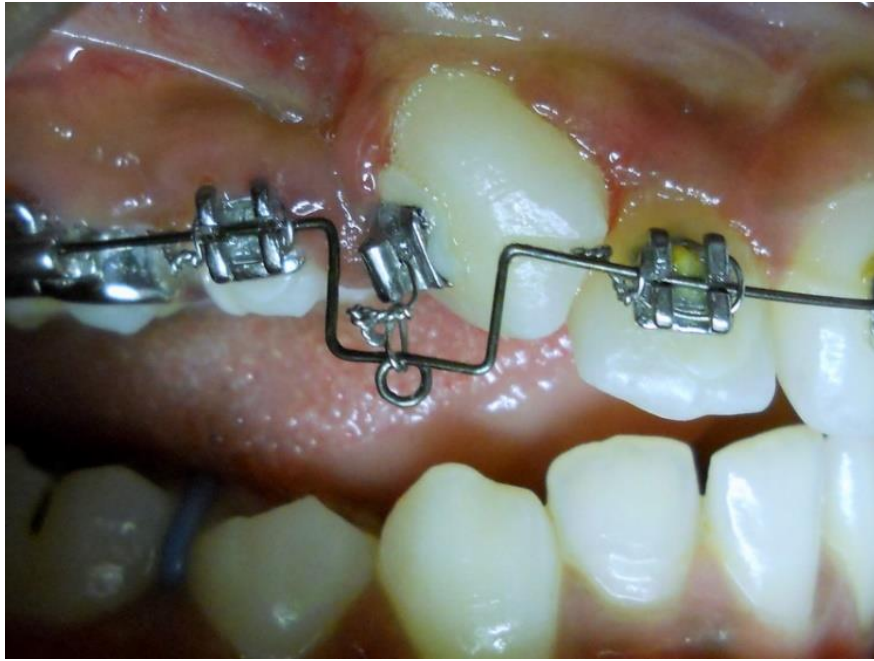
If all factors are favourable and the space deficit necessitates an extraction, it may be expedient to extract a severely displaced regular tooth and use the morphologically matched supernumerary tooth as a substitute. The latter would need specialised management, especially if the supernumerary tooth is impacted.



*Figure 171: Orthopantomograph of a patient with Cleidocranial Dysostosis*



*Figure 172: Surgical exposure and engagement of an impacted canine*



*Figure 173: Eruption of an impacted canine with a modified ballista loop*

## Chapter 10

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### Debond and Retention

#### Debonding

Patients will hardly ever miss this appointment. Cross check on the patient records that all treatment objectives have been achieved before removing the appliance.

Debonding is done with a debonding plier. The tips of the plier are squeezed over the occlusal and gingival tie wings of the bracket and twisted. Fracture of the bonding agent usually occurs at the bracket tooth interphase, leaving some bond residue on the bracket and on the enamel surface. When all brackets and tubes have been debonded, the orthodontic appliance is removed as a unit.

Always ensure that all the attachments have been removed from the patient's mouth, particularly if the distal ends of the wire were not cinched or if ligation elements on the brackets are missing.

The procedure is more cumbersome and risky when tooth coloured brackets are used as these brackets do not come off easily and enamel fractures are a risk.

Residual bonding agent should be removed from the tooth surface using a fluted tapered tungsten carbide bur in a slow hand piece.

An ultraviolet curing light can be used to expose and detect the presence of bond residue.



*Figure 174: Bond residue on a tooth*

Any tooth whitening procedures may cause tooth sensitivity and patients should be advised to delay this procedure by 6 months to allow for natural remineralization of decalcified areas to occur.

Regrettably, it may sometimes be necessary to debond the patient before all treatment objectives are met. This may happen when the risk of treatment due to non-compliance, or other factors outweighs the benefit of continuing with treatment. This should be carefully explained to the patient or his/her guardian and should only be undertaken by mutual consent in writing, between patient and operator. The ethical scales of medical care must always favour benefit over risk.

## Retention

The stability of the final result must be considered from the initial planning stage through the treatment to the debond stage.

Always treat within the biological limits of the neuromuscular and bony framework. Any infringement of tooth position beyond the physiological boundaries of the musculo-skeletal system will result in relapse and undesirable sequelae.

Retention appliances may be fixed or removable. Patient compliance and the type of malocclusion treated will influence the choice of retainer. A fixed 3 to 3 retainer for the lower arch, while a Hawley appliance for the upper arch is a recommended choice as the latter can tolerate minor adjustments. A fixed retainer on the upper arch bears the potential to interfere with the occlusion and may come loose.

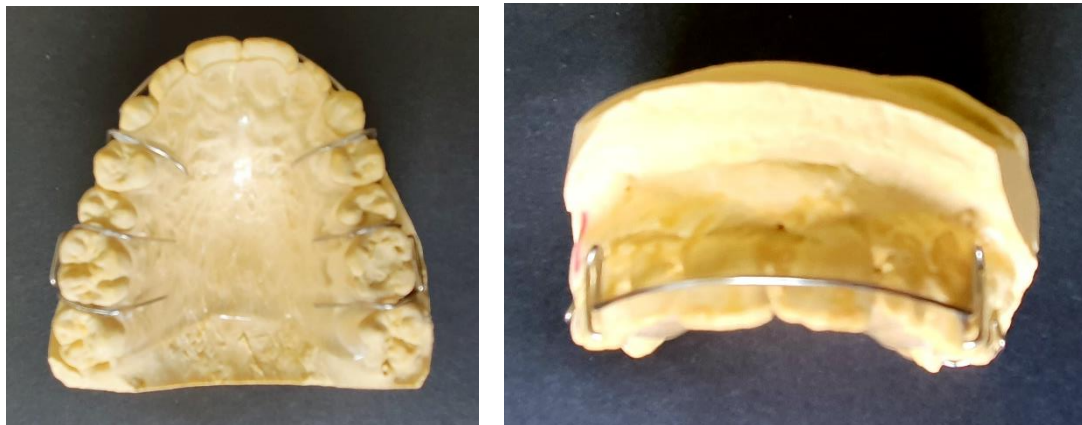


*Figure 175: Fixed bondable retainers – preformed and on a reel*

Clear thermoplastic retainers may also be used for both arches but these have a tendency to wear through and break.



*Figure 176: Clear thermoplastic retainers*



*Figure 177: Upper Hawley retainer*

Retainers must be checked and reinforcement of retention compliance must be done at 3-month intervals and depending on the initial malocclusion, retainers should be worn for 6 months, a year or even for life.

Both written and verbal instructions on retainer practice should be delivered to the patient with a clear warning that a failure to comply will result in relapse and that re- treatment bears a cost.



# Chapter 11

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## Orthodontic Mishaps

### Bracket debonds and repairs

Bracket breakages are undesirable and retard the efficacy of fixed orthodontic care. Undesirable tooth movement and treatment time relates almost exponentially to the time between a bracket debond and the repair thereof. While poor patient compliance and oral hygiene are likely causes of bracket debonds, excessive force and poor bonding cannot be dismissed as iatrogenic causes of bracket debonds.

In order to avoid unwanted tooth movement and extended treatment time it is advantageous to replace a deboned bracket as soon as opportunity permits.

Always use a new bracket and bill the patient for the repair if the debond is not due to operational neglect. A light cure bonding system is effective for optimization of the repair procedure.

A clause pertaining to the cost for bracket breakages must be contained in the informed consent agreement.

### Other casualties

### Impressions

Gagging on taking impressions can be discomforting for both the operator and patient, and is an issue that might be addressed by an adjustment in the operator's technique. The introduction of intraoral digital scans and printed models also holds promise for an improvement in the standard of care.

### FOA Irritation

As the dentition levels during treatment, the AW that initially had a roller coaster arrangement tends to straighten causing it to lengthen and project distal to the molar tubes. This distal projection of the wire can dig into the buccal mucosa and must therefore be checked and trimmed with a distal end cutter at every recall visit. A blob of light cure bonding agent may also be used to cover the wire tip. The patient should also be supplied with wax to cover any irritation cause by the appliance. In an emergency situation where orthodontic assistance may be inaccessible, wax that is used to filter sound, may be

obtained without prescription from a pharmacy, and could be used until the patient sees his/her practitioner.

Bracket irritation can also be relieved with wax that should be supplied to the patient. However, excessive and injudicious use of wax may result in debonds and the practice should therefore always aim to use quality brackets.

Operators should also be vigilant of the possibility of the development of an Epulis where the patient sucks buccal or labial mucosa through spaces between wire and teeth. Patients should be warned to avoid this tendency.



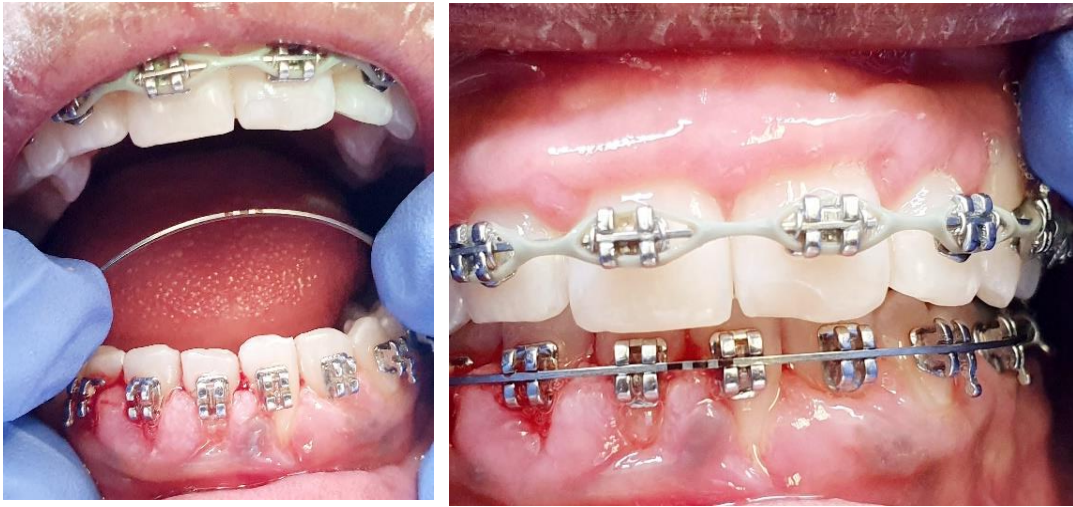
*Figure 178: Tissue trauma due to the FOA*

Patients having a history of allergies may also be allergic to Nickel which is a component of many AWs particularly SS. If an allergy to nickel is suspected, a finger ring made out of SS should be made for the patient to wear for a week before commencing active treatment. If the patient has an irritation of the skin around the ring, Nickel free appliances should be used.

Acid burns may occur due to leaching during the enamel etching procedure. Always use a coloured etchant to enhance its visibility.

Gingival swelling, hyperplasia and bleeding is mainly a result of poor oral hygiene and may deteriorate to a point where treatment may be suspended due to an encroachment of the FOA by the gingiva. Plaque index is indicative of the plaque present on the teeth at a point in time and should not be used as a measure of the patient's oral hygiene practice and level of compliance. The gingival index is a more reliable indicator of the patient's long-term oral hygiene practice, as it measures swelling and bleeding of the gums.

During recall visits, patient motivation to good oral hygiene practice should be reinforced and patients should be educated about the difference between plaque index and gingival index as a measure of cooperation and compliance.



*Figure 179: Gingival hyperplasia around the FOA*



*Figure 180: Gingival inflammation due to poor oral hygiene*

## Chapter 12

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### Cases that need specialised care

Always practice within the scope of the profession

Patient who need specialised orthodontic treatment include the following:

- Dental and Skeletal Class II and III patients
- Patients with multiple impacted teeth and severely impacted canines
- Patients with multiple missing teeth
- Comprehensive management of cleft palate and other syndromic patients
- Patients with Bimaxillary Protrusion
- Adult patients with any of the above conditions especially those needing multidisciplinary care.

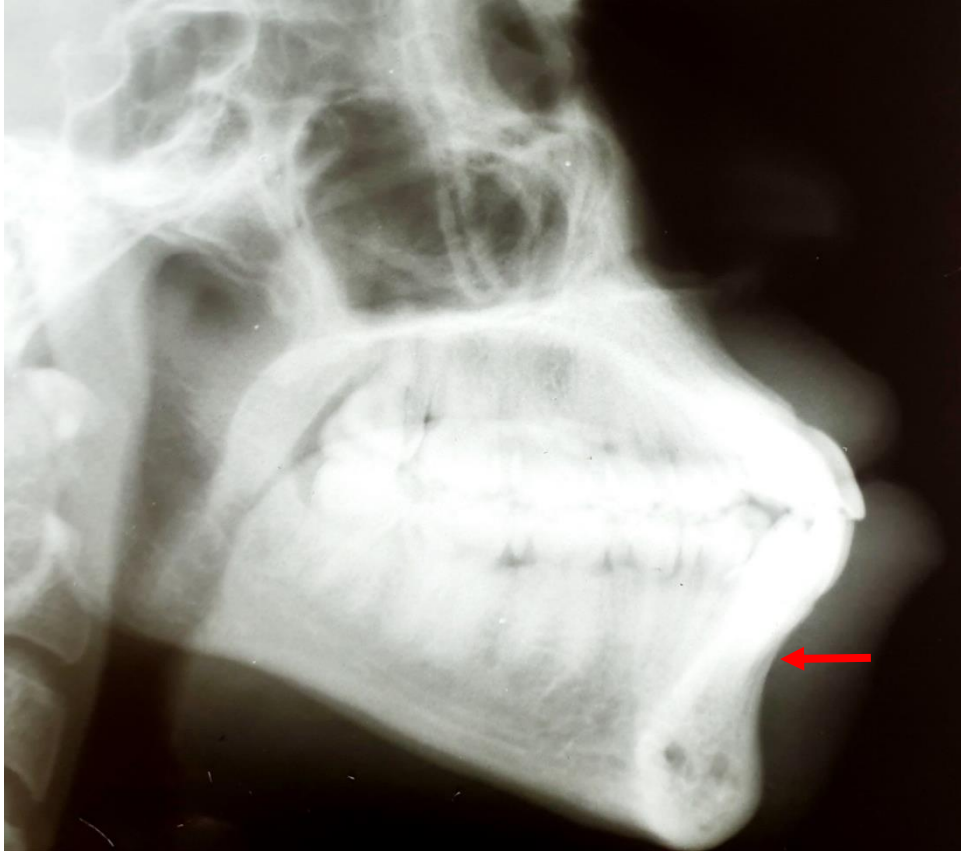
### Bimaxillary Protrusion

Bimaxillary Protrusion is a normal facial feature among many indigenous African and East Asian races and some patients may shy away from complaining about the procumbency of their teeth and lips. Patients may complain about problems unrelated to incisor protrusion.

In compliance with informed consent, the clinician is obliged to educate the patient of their dentofacial evaluation and the practitioner's ability to address the patient's concerns, empowering the patient to make informed choices.

Should it be established that the patient desires the Bimaxillary Protrusion to be addressed, the patient should be referred to a Specialist Orthodontist.

As the lateral cephalogram below illustrates there are two likely dangers associated with the orthodontic management of Bimaxillary Protrusion, namely, fenestration or dehiscence of the lower labial alveolar bone,;and mismanagement and loss of anchorage with a failure to reduce the patient's facial procumbency.



*Figure 181: Narrow ('gooseneck') symphysis of a Bimaxillary protrusive patient*

## Chapter 13

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### Early Management of the Cleft Lip and Palate infant

Although not in the ambit of the FOA, Cleft Lip and Palate is a primary health care need and in terms of the proposed National Health Insurance, the GDP may at some time be faced with a consultation of a cleft lip and/or palate baby. Although this is a condition that needs to be referred to and managed by an orthodontic specialist who would treat and coordinate the multidisciplinary care of the patient, the GDP may play a vital role in the early management of cleft lip and palate neonates.

The GDP should therefore be knowledgeable about the stages of treatment for the cleft patient and the involvement of the various specialties in Dentistry so as to inform, advice and reassure the patient, parents and/or caregiver. The treatment for a cleft patient starts at birth and depending on the severity of the condition may extend into adulthood. A timeline of the various treatment procedures would usually entail the following:

*Table 3: Treatment strategy for a cleft patient.*

<b>1-3 days</b>	Consultations: Paediatrics - patient GDP- patient (obturator and lip taping) Genetic and psychological counselling – parents
<b>6 months</b>	Lip / Cleft repair(primary)
<b>1-8 years</b>	Speech therapy
<b>1-5 years</b>	Paedodontics
<b>6-15 years</b>	Orthodontics and dental care
<b>16-20 years</b>	Orthodontics dental care and surgery

The fabrication of an obturator is no different from making an upper acrylic denture base and in the digital age, it is even simpler. It involves the taking a digital image of the baby's cleft, printing a model, and having a 1mm thick medium to soft thermoplastic sheet wrapped over the model. Once set, the excess is trimmed off the moulded sheet. The obturator is then fitted into the baby's mouth and an immediate feed is initiated.

As with all things foreign, the patient will at first reject the obturator but hunger and the welcome taste of nutrition should prevail. The parent should however be advised to persevere but persist with using the obturator. It should be cleaned after every feed and returned and left in the baby's mouth between feeds. Successive obturators may need to be supplied on a six weekly basis to accommodate, compensate and direct the infant's palatal growth.

Research is currently underway to evaluate the potential of successive obturators as described above and referred to as AMOs (alveolar moulding obturator) fabricated on progressive CAD models modified to direct palatal growth in a manner to align the alveolar arches and decrease the size of the cleft.



*Figure 182: Progressive CAD models with AMOs*



*Figure 183: Clinical application of the AMO*

Another intervention that the GDP can undertake is taping of the cleft lip. This procedure was once used, but became unpopular because of the robust adhesion of the tape, allergic reactions to the tape, moisture retention and unhygienic and infective aspects of the tape. With the advent of Physiotape®, lip taping is again a procedure of choice as it does not have all the negative properties of previously used tape but also has the added benefit of elasticity which can assist in reducing the cleft lip size.

*Figure 184: Cleft lip taping with Physiotape® – before and after treatment*



Both the AMO and lip taping can be effective treatment modalities applied by the GDP immediately after the birth of the infant and used for the first six months of infancy prior to surgical intervention.

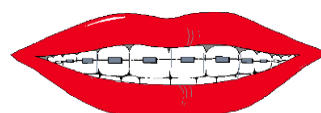
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## Appendix

### **ORTHODONTIC PATIENT INSTRUCTIONS**

Congratulations you are now wearing braces. It is important that you and your caretaker understand certain requirements that you must comply with while undergoing orthodontic treatment so that we can achieve the best results for you in the shortest time.

We want your orthodontic treatment to be a pleasant experience. If you follow all instructions carefully (e.g. brushing properly, avoiding harmful foods and wearing appliances as told) you will be a **HAPPY PATIENT**.



## **WHAT TO EXPECT DURING TREATMENT?**

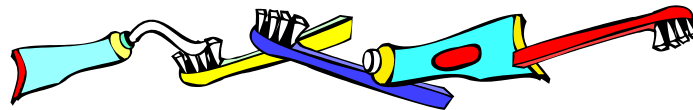
Once the braces are placed and wires are activated for the first time, you may have discomfort for about a week. A mild analgesic can be taken if needed to relieve your discomfort. There will be little or no pain after the first week of treatment.

Your speech may be affected after placement of an appliance. Read aloud to yourself and you will quickly adapt to the new situation.

## **BRUSHING WITH BRACES**

Brushing your teeth will at first be a little more difficult. We recommend that you must brush your teeth and gums carefully in the morning, evening and each time you eat something (even snacks). Remember to take a toothbrush to school or work (a travel toothbrush, is very handy for this purpose). If it is not convenient to brush, at least rinse your mouth with water after eating.

***NB!! Poor tooth brushing will lead to bracket failure tooth decay;***



***permanent stains on your teeth and swollen or bleeding gums.***

You must brush the outside, inside and chewing surfaces of all your teeth. Hold the brush so that the bristles can clean above and below each bracket. Then turn the brush so that the bristles can slide under the AW and also clean under the gums. Next, rinse your mouth and

check your teeth, gums and appliance(s) in a mirror. All the bands and wires should be free of food particles and plaque and the orthodontic appliance should shine. If not completely clean..... brush them again!

It is a good idea to use plaque disclosing tablets at least once a week to check that you are brushing correctly.

Dental floss and/or interdental brushes can be used to remove plaque that the toothbrush cannot reach.

## **BRING YOUR TOOTHBRUSH WITH TO EVERY**

## **VISIT SO THAT WE CAN GUIDE AND ASSIST YOU.**

We recommend that you use a fluoride containing mouth rinse such as, Listerfluor®. After brushing, rinse your mouth with a capful for one minute. Spit out and do not rinse with water. Try not to eat or drink for half an hour after rinsing.

## **FOOD & EATING HABITS**

Certain foods can damage, break or bend your appliances and should be avoided during your treatment. **HARD FOOD** bends wires and breaks off brackets. **STICKY FOOD** bends wires and loosens cement. Highly **SWEETENED FOOD & DRINKS** cause tooth decay and if frequently used while your braces are on, will cause white decalcification rings on the teeth after we remove the braces.

### **DO NOT EAT:**



- Sweets, toffees or chewing gum
- Hard crusted bread or bread rolls
- Mielies as in corn-on-the-cob
- Any food with a high sugar content
- Don't eat meat off a bone e.g. chops. Cut the meat off the bone into small pieces before eating it. Do not eat tough meat.
- Ice

**DON'T DRINK** - Lemon juice

Or any drinks with a high sugar or acid content.

**BE CAREFUL!** - Cut apples into wedges and

Cut raw carrots, celery etc. into small pieces before eating.

### **EMERGENCIES**

#### **LOOSE BANDS, BRACKETS / BENT WIRES / BROKEN APPLIANCES**

If your appliances are broken or bent, your teeth will not move. In fact they will move where we don't want them to move

And, this will mean wearing your braces longer.

**Make an appointment to see us immediately.**

Bring all bits & pieces of broken appliances with you.

#### **WIRES THAT HURT**

If catching your lips or cheeks on the brace is

painful, apply a small piece of cotton wool and 'snag' it onto the wire to let the sore heal. Alternatively, place a small blob of wax, which you can get from us, onto the offending wire or bracket.

#### **LOST APPLIANCES**

Make an appointment to see us immediately.

### **RETENTION**

At the completion of active treatment -which normally lasts for about 2 years - you will begin the period of **retention**. To retain teeth means to hold them in their new positions until the tissues, i.e. the bones, the elastic attachment around the root, the gums, the tongue and the lips have adapted themselves to the new tooth positions. **Without retention, teeth will move from their new positions to their original positions.**

### **PROFESSIONAL FEES**

Your treatment is in your own interest. Poor co-operation and compliance will only extend treatment time and cost. **It is therefore important that you understand these instructions.**

Please contact us if clarification of these instructions or additional information is required.

# **Glossary**

## **Adam's Clasp**

A clasp used to anchor a Hawley retainer to the teeth by gripping each anchor tooth securely with arrow heads and engaging the undercuts on the mesiobuccal and distobuccal surfaces of the tooth, usually a molar tooth.

## **Adenoids**

Masses of lymphoid tissue in the nasopharynx which classically have been associated with airway obstruction and mouth breathing, with all the suggested consequences – hence the term “adenoid facies.”

## **Adenoid Facies**

A descriptive term to imply the classic features of a child with nasal obstruction due to enlarged adenoids. Features include a narrow nasal width, hypotonic musculature, separated lips at rest and a 'vacant' facial expression.

## **Adjunctive orthodontic treatment**

Treatment given in addition to a primary orthodontic procedure that is essential for achieving an optimal restoration of function and aesthetics.

## **Asymmetry**

Degree of imbalance or deviation in both qualitative and quantitative features in structure, relationship or both.

## **Anchorage**

The sites that provide resistance to the reactive forces generated.

## **Infinite anchorage**

The term is commonly used when referring to implants used as anchorage in orthodontics, to indicate that they show no movement.

## **Intermaxillary anchorage**

Anchorage for tooth movement provided by the teeth of the opposing arch.

## **Intramaxillary anchorage**

Anchorage provided by teeth within the same arch as the ones that are to be moved.

**Maximum** (Static or Type A anchorage)

A situation in which the treatment objectives require that no or very little anchorage can be lost.

**Minimum anchorage** (Type C anchorage)

A situation in which, for an optimal result, a considerable movement of the anchorage segment (anchorage "loss") is desirable.

**Moderate anchorage** (Reciprocal or Type B anchorage)

A situation in which anchorage is not critical and space closure should be performed by reciprocal movement of both the active and the anchorage segment.

**AW stop**

A bend, auxiliary attachment, or occasionally a drop of solder placed on an AW to prevent it from sliding mesially or distally through the orthodontic attachments.

**Bite plane**

A removable appliance made of acrylic designed to open a deep bite or recommended for people who grind their teeth.

**Bonding**

Denotes the process by which orthodontic attachments are attached to the teeth. The most commonly used bonding techniques involve acid etching and composite resin, or conditioning and glass-ionomer cement.

**Direct bonding**

An intraoral procedure in which orthodontic attachments are oriented by inspection and bonded on each tooth individually. Direct bonding does not require a laboratory stage.

## **Indirect bonding**

A two-step procedure for bracket placement. Brackets are first placed temporarily on a plaster cast and subsequently transferred "en masse" to the mouth by means of a transfer tray (template). The transfer tray preserves the pre-determined orientation of the brackets and allows them to be bonded concurrently.

## **Bonding agent**

A material that, when applied to surfaces of substances, can join them together, resist separation, and transmit loads across the bond. Available bonding agents for orthodontic use include, in addition to the conventional composite resins, light-curing composite resins and glass-ionomer cements, as well as hybrid materials comprising glass-ionomer and composite components

## **Bracket**

Precisely fabricated orthodontic attachment made of metal, plastic or ceramic material, which can be bonded to a tooth or welded to a band. It carries a horizontal and/or a vertical channel of standard size, called a "slot," that can receive an AW or other orthodontic accessories as part of a FOA.

## **Metal bracket**

The most widely used brackets, typically made of SS. The main drawback of metal brackets is their colour and visibility, which may be undesirable to some patients. However, metal brackets have been miniaturized significantly through continuous redesigning by manufacturers. One additional limitation may be related to nickel hypersensitivity in some patients, when SS brackets are used.

## **Tooth coloured bracket**

The early plastic brackets were made of polycarbonate and plastic moulding powder. These brackets did not last long because of discoloration, fragility and softening with time resulting in poor integrity of the bracket slot. Several improvements have been made to reinforce plastic brackets and to improve their colour stability, including precision-made SS slot inserts to reduce friction and ceramic material fillers (15% to 30%) to strengthen their matrix.

## **Buccal tube**

A small metal attachment that is welded on the outside of a molar band or bonded to a tooth. The buccal tube contains a slot to hold AWs, and may have additional slots for lip bumpers, face bows and supplementary AWs.

## **Centre of resistance**

Analogous to the centre of mass for an in vivo tooth such that any force acting through a tooth's centre of resistance causes the tooth to translate.

### **Centre of rotation**

Point located either internal or external to a rotating body around which it turns. Located at variable points depending on how far a given force is applied from the centre of resistance (approaching, but never reaching, the centre of resistance.)

### **Cheek retractors**

Small plastic pieces used to draw back the lips and cheeks so that the orthodontist can more easily see the teeth and work on them.

### **Circumferential supracrestal fibrotomy (CSF)**

An adjunctive periodontal surgical procedure to reduce the relapse tendency of corrected individual tooth rotations. The procedure consists of inserting the sharp point of a fine blade into the gingival sulcus, down to the crest of the alveolar bone, to sever the gingival fibres around the tooth (including the trans-septal fibres between it and the adjacent teeth).

### **Crimpable attachments**

A number of different orthodontic attachments (e.g. hooks, stops) that can be fixed on an AW by squeezing their base with sharp beaked or specialised pliers.

### **Crossbite**

"Crossbite" refers to a condition where one or more teeth may be abnormally malposed buccally or lingually with reference to the opposing tooth or teeth.

### **Crowding**

An orthodontic problem caused by having too many teeth in too small a space.

### **Curve of Spee**

Curvature of the incisor edges and occlusal surfaces of teeth beginning at the tips of the lower incisors and canine, following the buccal cusps of the premolars and molars, and continuing to the last molar tooth.

### **Dental anomalies**

Abnormalities of tooth condition or development, such as tooth agenesis, peg lateral incisors, dens invaginatus, taurodontism, ectopic eruption, and root abnormalities, etc.

### **Dental camouflage**

Treatment of Class II or Class III skeletal problems with the intent to disguise the unacceptable skeletal relationship by orthodontically repositioning the teeth in the jaws so there is an acceptable dental occlusion and aesthetic facial appearance.

### **Deep bite**

“Deep bite” describes a condition of excessive overbite, where the vertical measurement between the maxillary and mandibular incisal margins is excessive when the mandible is brought into habitual or centric occlusion.

### **Diastema**

A space between two teeth. Midline diastema is a space between maxillary central incisors.

### **Distal end cutter**

A special plier used to cut off the ends of AWs.

### **Drift**

Free and unassisted movement of teeth into empty spaces in the dental arch.

## **Elastic Forces**

### **Class I elastics**

Elastics extending unilaterally or bilaterally from the anterior aspect to the posterior aspect of the same arch.

### **Class II elastics**

Intermaxillary elastics extending unilaterally or bilaterally from the anterior aspect of the maxillary dental arch to the posterior aspect of the mandibular one.

### **Class III elastics**

Intermaxillary elastics with the opposite orientation to Class II elastics. As in the instance of Class II elastics, Class III elastics can be used unilaterally or

bilaterally. They have various applications: to facilitate protraction of maxillary posterior teeth, to improve the incisor relationship in an edge-to-edge or anterior crossbite situation, or to make use of intermaxillary anchorage during mandibular incisor retraction.

### **Crossbite elastics** (Through-the-bite elastics)

Elastics extending from the palatal (lingual) aspect of one or more maxillary teeth, to the buccal aspect of one or more mandibular teeth (or the reverse), to aid in correction of a crossbite. Crossbite elastics create vertical forces in addition to the desirable transverse forces; they should therefore be used with caution, especially in patients with minimal overbite and a long anterior lower facial height.

### **Vertical elastics** (up-down elastics, Box elastics, Triangular elastics, Zig-zag elastics)

Intermaxillary elastics in various configurations, aiming at extrusion of teeth. They are used to aid in settling (improve the interdigitation) in the final stages of active treatment, to achieve closure of a localized OB, or to aid in postsurgical levelling of the mandibular curve of Spee by premolar extrusion.

### **Anterior diagonal elastics (Anterior oblique elastics)**

Anterior intermaxillary elastics crossing the midline, often used to facilitate the correction of non-coinciding maxillary and mandibular dental midlines.

### **Elastomeric ligature** ("Donut," "O-ring")

A small ring of elastomeric material that is stretched around the tie-wings of an orthodontic bracket for the purpose of preventing disengagement of an AW or auxiliary from a bracket slot.

### **Elastomeric chain**

A chain of connected elastomeric rings used as a force-producing mechanism for orthodontic tooth movement. Elastomeric chains can be short or long linked, depending on the distance between the rings in its passive state.

### **Extraoral appliances**

Headgear and other appliances frequently prescribed for anchorage control, securing the posterior teeth to extraoral structures.

### **Force**

The action of one body on another body that tends to change the state of rest or motion of the latter. Orthodontics is based on the application of forces on teeth, under the influence of which tooth movement can be achieved.

Force is a vectoral quantity. To adequately describe a force, its magnitude, direction (line of action), sign (sense) and point of application have to be defined.

### **Force combinations**

Determination of a resultant force by combination of two or more component forces. When two component forces have a common point of application, the resultant force is determined by considering the two vectors to be sides of a parallelogram. The resultant force then is the diagonal of the parallelogram. Its length indicates the magnitude of the resultant force on the same scale as the original forces.

### **Friction**

A force resisting the relative displacement of two contacting bodies.

Static friction is the component of frictional force that has to be overcome to initiate motion.

Dynamic (kinetic) friction is the component of frictional force that has to be overcome to maintain motion. The static frictional force usually is somewhat higher than the dynamic frictional force.

### **Functional shift**

Discrepancy between centric relation and centric occlusion as a result of premature tooth contact that deflects the mandible.

### **Guided extraction (Serial extraction)**

Removal of certain primary and permanent teeth in a definite sequence

### **Heat treatment**

The thermal processing of a material for a certain period of time, above room temperature but below the melting temperature. The effects of heat treatment depend entirely on the temperature, the duration of the process, and the type of material. Heat treating, for example, may harden or soften a metal, or change its grain size or corrosion resistance.

### **Hyrax appliance**

A commonly used type of banded rapid maxillary expansion appliance. The framework of the appliance is made entirely of SS. Bands are cemented (usually) on the maxillary first premolars and first molars. The bands are

connected by means of rigid wires to a special expansion screw which is located in the midline of the palate.

### **Incisor liability**

A factor related to the ratio between the primary and permanent incisor tooth size that may influence the overall arch length.

### **Informed consent**

The outline of the patient's problems along with the possible solutions, in a simplified fashion comprehensible to the patient. Reasonable treatment alternatives and the risks and benefits of each alternative should be provided. In this way, the patient is able to make an informed decision about his/her treatment. Informed consent is a legal requirement prior to treating patients

### **Interceptive treatment**

Therapeutic measure directed at eliminating habits or inserting a space maintainer after the premature loss of primary teeth.

### **Interproximal reduction or IPR** (interproximal stripping)

Reduction of the mesiodistal width of the teeth by removal of interproximal enamel. This procedure can be achieved by means of handheld or motor-driven abrasive strips, or handpiece-mounted abrasive discs, or by means of a tapered fissure carbide bur.

### **Kobayashi hook** (tie, ligature)

A ligature fabricated from 0.012-inch (0.30-mm) or 0.014-inch (0.35-mm) annealed SS wire, whose legs are welded onto each other, forming a helical "hook" at its end. It is placed on a bracket below the AW or in the same way as a regular stainless SL and it is used for the attachment of orthodontic elastics.

### **Laceback**

Stainless SL placed passively in a figure-eight mode (usually from the terminal molar to the canine of the same quadrant), as part of the levelling and alignment stage of treatment.

### **Levelling**

The phase of comprehensive orthodontic treatment aiming at flattening the curve of Spee until the marginal ridges of all the teeth in the arch lie more or

less in the same horizontal plane. Thus, levelling refers to correction in the vertical plane.

### **Levelling wire**

Any AW that is used for levelling.

### **Ligature stainless steel**

A ligature made from annealed SS wire (0.008 to 0.012 inch, or 0.20 to 0.30 mm, in diameter) that engages under the bracket tie-wings (usually with the help of a Mathieu needle holder and is twisted until it tightens around them, holding the AW or other orthodontic spring in place. The excess wire is cut and discarded, and the twisted end ("pigtail") is tucked under the AW for patient comfort.

### **Leeway space**

The space differential between the primary and permanent teeth in the posterior segments.

### **Lip bumper**

A lip bumper is an appliance used to push the molars on the lower jaw back to create space. It consists of a thick AW which engages into the buccal tubes of the lower molars and has a moulded piece of plastic which wedges between the lower lip and lower incisor teeth.

### **Lip incompetence**

Absence of upper and lower lip apposition.

### **Lingual appliances**

An orthodontic appliance that is fixed to the lingual and palatal surfaces of teeth.

### **Lingual arch**

A thick orthodontic wire attached to the bands from molar to molar in the lower arch.

### **Lingual retainers**

A fixed attachment from cuspid to cuspid on the lower arch.

### **Loops**

Loops are used for a number of purposes, such as to lower the load/deflection rate by addition of more wire. Examples are: Boot loop, Box loop, Closing loop, Omega loop, Open loop, T-loop, Teardrop loop.

## **Malleability**

The ability of a material to sustain considerable permanent deformation without rupture, under compression.

## **Martensite**

A body-centred cubic phase in SSs, or a monoclinic, triclinic or hexagonal crystalline structure of nickel-titanium alloys. The martensitic phase of nickel-titanium exists at lower temperatures and is characterized by high ductility.

## **Martensitic transformation**

The transition into a crystalline structure called martensite. In nickel-titanium alloys martensitic transformation involves only a shearing movement of the atoms, without sliding of crystals past each other. Thus, the transformation can be reversed when increasing the temperature. The temperature at which the phase change occurs is termed transition temperature. This temperature depends on the composition and mode of fabrication of the alloy. In the martensitic phase (below the transition temperature), the wire has higher ductility, whereas in the austenite phase (above the transition temperature) it is more resistant to permanent deformation. A wire that is deformed while in the martensitic phase recovers its original shape at the return to the austenite phase (shape memory effect).

## **Mechanics**

### **Cantilever mechanics**

Orthodontic mechanotherapy using cantilever springs to generate the appropriate force systems for specific types of tooth movement. Because full bracket engagement is allowed only at the fixed end of the cantilever with one-point contact at the other end, a statically determinate force system is achieved.

### **Class I mechanics**

Orthodontic mechanotherapy utilising intramaxillary anchorage for tooth movement.

### **Class II mechanics**

Orthodontic mechanotherapy making use of intermaxillary anchorage (e.g. elastics) between the anterior aspect of the maxillary and the posterior aspect of the mandibular arch.

### **Class III mechanics**

Orthodontic mechanotherapy utilising intermaxillary anchorage (e.g. elastics) between the anterior aspect of the mandibular and the posterior aspect of the maxillary arch.

### **Closing loop mechanics**

The teeth in an arch are consolidated into segments: active and passive (for anchorage). Force is then applied between these segments to close the extraction space. Closure of space is usually done by loops (potential energy-loaded springs) constructed from regular orthodontic AWs. All closing loops have specific mechanical properties (i.e., response to mechanical forces).

### **Continuous AW mechanics**

Orthodontic mechanotherapy utilising continuous AWs in the entire dental arch.

### **Frictionless mechanics**

The use of strategies or appliances that do not involve friction between AW and bracket during tooth movement.

### **Intermaxillary mechanics**

The application of forces and/or moments from one arch to the other.

### **Inter-segmental mechanics**

The application of forces and/or moments from one segment of teeth to another.

### **Intra-segmental mechanics**

The application of forces and moments between teeth that belong to the same segment of an arch.

### **Segmental arch mechanics** (Sectional mechanics)

Orthodontic mechanotherapy in which not all teeth within an arch are included in the same AW.

### **Sliding mechanics**

Mechanotherapy involving sliding of brackets along the AW during tooth movement (i.e. the classic "pearls on a chain" example). The AW generates the counter-moment necessary for bodily movement of the teeth. Frictional forces are present when tooth movement is performed by sliding mechanics.

### **Moment of a couple**

The moment of a couple produces a tendency to pure rotation around the centre of mass (when applied on a free body), or around the centre of resistance (when a partially constrained body, e.g. a tooth, is involved).

### **Moment of a force**

The moment of a force about a specified point or line is a measure of the potential of that force to rotate the body, upon which the force acts, about the particular point or line.

The moment  $M$  of a force  $F$  about a point is also a vectoral quantity. Its magnitude is given by the formula  $M = F \times d$  (where  $d$  is the moment arm length). A moment of a force is also measured in units of force  $\times$  distance (i.e. N mm, or g mm). The direction of the moment vector is perpendicular to the point defined by the force vector and the point about which the moment is considered. By convention, counter-clockwise moments (out of the plane) are said to be positive, whereas clockwise moments (into the plane) are considered negative.

The shorter the moment arm, the smaller the moment of a force.

surface of the band can be conditioned by various methods such as pattern rolling, sandblasting, photo- or laser-etching to increase retention.

### **Models**

Three-dimensional plaster representation of the patient's dentition used to assess the malocclusion including the Angle classification of molars and canines, the overbite and overjet, the approximate amount of crowding or spacing in a particular dental arch, and the presence of an anterior or posterior crossbite.

### **Nickel titanium or (NiTi)**

An especially flexible orthodontic wire with shape-memory which allows for rapid tooth movement.

### **Orthodontic Attachment**

A precision component that can be welded or soldered to a band, or bonded directly to a tooth, to facilitate the application of forces during orthodontic treatment.

### **Orthodontic band**

A ring, usually made of a thin strip of SS, that serves to secure orthodontic attachments to a tooth. Bands are prefabricated in varying shapes to fit closely around the crowns of specific teeth. Each shape comes in different sizes to accommodate individual tooth size variation. Most bands have an occluso-

gingival taper to fit the tooth. Orthodontic bands can be plain or have buccal (brackets or tubes) or lingual (buttons, sheaths, cleats, seating lugs) attachments welded or brazed on them.

### **Open bite**

OB is descriptive of a condition where a space exists between the occlusal or incisal surfaces of maxillary and mandibular teeth in the buccal or anterior segment, when the mandible is brought into habitual or centric occlusion

### **Orthodontic cement**

Dental cement used for fixation of orthodontic bands to the teeth.

### **Glass-ionomer cement**

A poly-electrolyte dental cement produced by mixing a fluoride-containing aluminium silicate glass powder and a solution of polyacrylic acid. Due to ion transfer between the calcium of the tooth and the polyacrylic acid of the glass-ionomer cement, a high bonding strength can be achieved, especially when there is good moisture control. This inherent adhesion to tooth structure, as well as their long-term release of fluoride ions (with cariostatic potential) are the two main advantages of glass-ionomer cements.

### **Orthodontic force magnitude**

Factor used to move a tooth. Usually varies between 15 and 400 g, depending on the size of the tooth or, more specifically the root surface area, as well as the type of tooth movement and the friction of the appliance.

### **Overbite**

The term overbite applies to the distance which the maxillary incisal margin closes vertically past the mandibular incisal margin when the teeth are brought into habitual or centric occlusion.

### **Overjet**

Overjet is a horizontal measurement referring to the distance between the lingual aspect of the maxillary incisors and the labial surface of the mandibular incisors when the teeth are in habitual or centric occlusion.

### **Posterior crossbite**

Malocclusion in which one or more primary or permanent posterior teeth are locked in an abnormal relation with the teeth of the opposite arch.

### **Preadjusted appliance**

Orthodontic appliance designed to achieve high-quality orthodontic results with minimal wire bending and simplified mechanics. An alternative to the standard edgewise bracket system.

### **Quad-helix appliance**

An all-wire fixed orthodontic expansion appliance made of a 0.036-inch (0.90-mm) SS wire, containing four helices (two anteriorly and two posteriorly). The wire is soldered onto bands on the maxillary first molars. The appliance is used for symmetrical or asymmetrical expansion of the maxillary dental arch.

### **Retainers**

Any orthodontic appliance, fixed or removable, used to maintain the position of the teeth and stabilise them following orthodontic treatment.

#### **Bonded lingual retainer**

A wire that is bonded on the lingual surface of the teeth just prior to or after removal of the orthodontic appliances to retain their corrected positions. Bonded lingual retainers are very popular in the mandibular anterior area to provide long-term retention in an attempt to prevent late mandibular incisor crowding. The type of wire used for this purpose ranges from a flexible multistrand wire to a rigid rectangular SS one. The wire can be bonded on all six mandibular anterior teeth individually, or only on the lingual surface of the canines. The use of maxillary bonded lingual retainers is dependent on the clearance provided by the overbite. Bonded lingual retainers occasionally are used on the maxillary central incisors to prevent relapse of a pre-existing midline diastema.

#### **Hawley retainer**

One of the most frequently used retaining devices. It is a removable appliance made of acrylic covering the entire mucosa of the hard palate.

Adams clasps or sometimes circumferential clasps on the first molars are used to provide retention.

A labial bow of 0.020-inch (0.51-mm) is made to contact the labial surfaces of the four incisors or the six anterior teeth. The labial bow has a U-loop where it crosses the occlusion, usually distal to the canines.

#### **Vacuum-formed retainer**

A type of removable retainer made of soft or hard clear thermoplastic material that is heated and formed on the patient's plaster model in a vacuum machine. The appliance may cover the entire arch or part of it, and it may also be used

for some minor individual tooth corrections, if the teeth are reset prior to its fabrication.

### **Rotation wedge**

An orthodontic auxiliary made of rubber or SS, which is used when a small degree of rotation of a tooth still is necessary, but there is no more activation left in the wire (e.g. when bracket placement is not ideal), and the clinician wants to avoid placing a bend. The wedge is attached on the side of the bracket that needs to be moved in a lingual direction, and subsequently the AW is ligated tightly on the opposite aspect of the bracket with a stainless SL, so that the wedge is squeezed between the AW and the tooth.

### **Round-tripping**

Movement of teeth in a direction opposite to that in which they were moved in an earlier stage of orthodontic treatment. It is thought to increase treatment time and the risk of root resorption significantly and thus should be avoided.

### **Scissors bit**

Malocclusion in the posterior teeth occurring when upper teeth are positioned totally buccal to the lower teeth in centric occlusion most frequently in the premolar region of Class II Division I malocclusions (Brody's syndrome).

### **Separation**

An orthodontic procedure aiming at slightly loosening the tight interproximal contacts between teeth to create space for the fitting of orthodontic bands.

### **Brass separator**

A piece of soft 0.020-inch (0.51-mm) brass wire, bent in the shape of a hook. The flattened edge of the hook is passed beneath the interproximal contact and slid around it. The two free ends of the separator wire then are grasped with a pair of Mathieu pliers and twisted tightly, so a separating force is created. The twisted end of the separator ("pigtail") is cut to a length of approximately 3 mm and tucked in the interproximal area.

### **Elastic separator**

Elastomeric ring of varying thickness that is placed around the interproximal contact point to create the necessary separation over time. The elastomeric ring is stretched with the help of special pliers while it is forced through the contact. An elastic separator (as any separator) can cause problems if lost into the interproximal space because they usually are radiolucent, so their position and number should be noted in the chart at the time of placement and the area thoroughly inspected in case of a missing separator at the banding appointment.

## **Separators**

Spacers placed between teeth to allow for the fitting of bands.

## **Serial extraction**

Procedure used when a patient is diagnosed with a Class I malocclusion and a severe tooth size-arch length discrepancy of 8 to 10 mm or greater during the early mixed dentition that involves the removal of primary canines and first molars first, followed by extraction of the first premolars once they are visible.

## **Space analysis**

Formulaic examination performed during the mixed dentition to determine whether the permanent teeth will have adequate space in which to erupt by predicting any arch length discrepancy of the permanent dentition.

## **Space maintainer** (Space-retaining appliance)

An orthodontic appliance, fixed or removable, used to control the arch length, usually following the early loss of a deciduous tooth (most commonly a second or first deciduous molar) until the eruption of its successor.

## **Springs**

### **Coil spring, Open**

An open coil spring comes in a spool and usually is cut to a length larger than the interbracket distance between the teeth that are intended to be moved away from each other. It is compressed prior to insertion, generating equal and opposite forces on either end.

### **Closing coil or Retraction spring**

Come in predetermined lengths with two eyelets on either end. Retraction coil springs are used to generate forces for retraction of teeth or space closure by extending them beyond their initial length.

### **Torqueing spring**

Auxiliary orthodontic spring used to move the root of a tooth in the labiolingual or buccolingual direction.

## **Stress-strain curve**

Measure of relationships associated with the intrinsic properties of a material in which the ratio of stress to strain in the elastic portion of the curve defines the modulus of elasticity of a material. The slope of a stress-strain curve within its elastic limit is an indicator of the stiffness or flexibility of a wire.

## **Supernumerary teeth**

Supplemental teeth – most often between maxillary central incisors. Also extra maxillary lateral incisors that children with clefts frequently have that are usually caused by the migration of the initiating cells from near the neural crest to the site of tooth formation.

## **Surgical exposure**

Procedure allowing the natural eruption of an impacted tooth. Involves removal of both soft and hard tissues in the direction most appropriate for crown movement.

## **Tooth movement**

Movement of a tooth under the influence of a mechanical force. Orthodontic tooth movement is possible because of the regenerative and remodelling capacity of the alveolar bone and the periodontal ligament.

### **Extrusion**

A translational type of tooth movement parallel to the long axis of the tooth in the direction of the occlusal plane.

### **Intrusion**

A translational type of tooth movement parallel to the long axis of the tooth in an apical direction.

### **Pure rotation**

Rotation of a tooth about its long axis, most evident when viewing the tooth from an occlusal perspective. To achieve this type of tooth movement, the application of a couple is required.

### **Translation** (Bodily movement)

The type of tooth movement during which all points on a tooth move in the same direction by the same amount.

### **Reciprocal tooth movement**

The situation in which both the active and the reactive segment of teeth move toward each other.

### **Torque**

Movement of the incisor roots. Rotation occurring around the bucco-lingual axis (See third-order tooth movement).

## **Translation**

Movement that occurs when all points on a body move the same amount and in the same direction when the force is directed through this centre of mass.

## **Wire Bends**

Bends to position anterior teeth for optimal mechanics or aesthetic appeal.

## **Cinching**

Placing a sharp bend on the AW distal to the terminal attachments in an arch. Cinching is done to avoid excessive proclination of the anterior teeth during levelling and torquing to prevent the AW from sliding in an anterior direction during the interval between patient visits

## **Distal-end bends** (Distal-end stops)

Bends (usually in a gingival and/or medial direction) made on the AW (after it is placed in all the brackets), distal to the terminal attachment.

## **First-order bends** (In-out bends,)

Labiolingual offsets (step bends) in the AW in the horizontal plane.

## **Second-order bends** (Tip bends)

Offsets in the AW in the vertical plane, to change the angulation (mesiodistal tip) of a tooth.

## **Step bends**

Labiolingual or occlusiogingival offsets in an AW, in such a way that the segments of the wire on either side of the bend remain parallel to each other.

## **Third-order bends** (Torquing bends)

Twists in a rectangular AW, placed when a change of the buccolingual or labiolingual inclination of specific teeth is desired.

## **Tip-back bends**

V-bends placed to tip teeth (usually molars) distally.

**Tip-forward bends**

V-bends placed to tip teeth mesially (the reverse of tip back bends).

**Toe-in bends**

V-bends in the horizontal plane, typically placed at the ends of an AW, to achieve derotation or constriction of the terminal molars.

**V-bends** (Gable bends)

V-bends generate different force systems between two teeth, or two segments of teeth, depending on the location of the "V" along the wire (in relation to the two brackets). When the V-bend is in the centre of the interbracket distance, the created force system involves equal and opposite moments between the teeth.

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